Lecture notes on the Five-day National Workshop on the Tradition of Indian Astronomy before the common era '26

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Introductory Note from the Lecture of Prof. M. D. Shrinivasa

Introduction: The Western Lens on Indian Astronomy

Since there were no texts published by us, and for various other reasons, modern history—as I have noted, the history of astronomy in India as developed by scholars in the West—continually asserted that much of Indian astronomy, even in the Vedic or the post-*Vedāṅga* periods, was borrowed from the West (with "West" then denoting Mesopotamia, Greece, or Egypt). Furthermore, it was claimed that *Siddhāntic* astronomy was deeply influenced by Greek, or Hellenistic, astronomy (specifically the Greek astronomy developed in Egypt) and later by Islamic astronomy.

For instance, Otto Neugebauer, in his famous book *A History of Ancient Mathematical Astronomy*, written in 1975, states:

"I think it is fair to say that practically all fundamental concepts and methods of ancient astronomy, for the better or the worse, can be traced back either to the Babylonian or Greek astronomy."

Thus, the implication was that nobody else engaged in scientific astronomy.

Consider the perspective of another prominent scholar, David Pingree. His view was that Indian astronomy was not completely static, but he attributed its development almost entirely to repeated intrusions of new theories from the West. He posited that five such intrusions occurred: in the 5th century BCE from Mesopotamia via Iran; in the 2nd and 3rd centuries CE from Mesopotamia via Greece; in the 4th century CE from Greece; from the 10th to the 18th century from Iran; and in the 19th century from England (and presumably the 20th century from America, extending his logic).

This perspective is evident in another article Pingree wrote in the *Proceedings of the National Academy of Sciences* in 1978. While my daughter was studying for her Ph.D. abroad, I did not have access to this article and asked her to send me a copy. She subsequently sent me an email saying, "Why are you reading writing like this? I thought Indians had done something in astronomy! By looking at this man's article, I'm wondering now what is it that is going on."

In another publication, published as an appendix summarizing mathematical astronomy in India for the *Dictionary of Scientific Biography*, Pingree reiterated his stance:

"Mathematical astronomy was introduced into India along with the sciences of divination from Central Omens and astronomy from the West."

He argued that it was not only astronomy that was Western, but all of Indian astrology and the science of omens as well. Crucially, he concluded:

"The preservation of this Greek material is one of India's greatest contributions to the history of science."

One could scarcely imagine a more backhanded compliment. This was written in 1978, a mere 45 years ago.

The True Scope and Purpose of *Jyotiṣa*

This is the historical background against which we are discussing this great tradition. Even as late as the 16th century, Nīlakaṇṭha Somayājī, in his *Jyotirmīmāṃsā*, begins with a quotation from the *Smṛti* section of the *Taittirīya Āraṇyaka*:

"By studying this, whatever the rules are, one attains the world of the Sun and becomes one with the Sun."

Thus, in the 16th century, scholars traced our astronomical tradition back to the *Taittirīya Āraṇyaka*, which has now gained prominence due to the *Abhaya Dhruva* discovery by Professor Iyengar.

Even Lagadha's *Jyotiṣa* explains the purpose of *Jyotiṣa* as a *Kāla Vidhāna Śāstra*—a discipline through which one observes the motion of celestial bodies to understand the nature and flow of time. Astronomers generally understand why time is included, alongside direction and geographical location on Earth. Astronomy is not merely an esoteric science of cosmology or celestial mechanics; it serves highly practical, mundane purposes. It is used to ascertain the time, to understand the passage of time on Earth, to determine one's location, to identify directions for constructing houses with proper orientation, and to forecast the weather, among other applications.

The vital principle unifying all these theories was that the content of the astronomical texts had to remain in harmony with empirical observation of the sky. This convergence is termed *Dṛk Gaṇita Aikya*. This principle is reiterated across all astronomical texts. The great text *Siddhānta Darpaṇa*, which is currently being edited here, contains this profound statement:

"Neither pure observation nor pure calculation alone is sufficient. It is observation and calculation which, when they go together, produce for us a very beautiful science of astronomy."

Early Common Era Astronomy and Key Texts

If we summarize the brief Common Era astronomy, what elements do we find? The main astronomical concepts embedded within the Vedic corpus include: large numbers, factors, fractions, sequences, and the decimal place-value nomenclature of numbers (referring to the system of naming numbers rather than calculating with them). It also includes the concept of zero and *Pūrṇa*. There is a substantial amount of observational astronomy: the 27 or 28 *Nakṣatras*; the identification of a *Dhruva Tārā* (Pole Star) corresponding to 2850 BCE; the motion of the Sun and Moon; solstices and equinoxes; the 18-year cycle of eclipses; comets; and numerous other phenomena that will be discussed further.

We also have the *Maitrāyaṇīya Upaniṣad* and the *Mahāsaṃhitā* section of the *Vṛddha Garga Jyotiṣa*, which records the summer solstice occurring in *Māgha*. (I will explain this alignment

shortly, and it will be covered extensively during the course). This observation corresponds to a period prior to approximately 1600 BCE.

Thus, we have a Pole Star recorded at 2800 BCE, a summer solstice recorded at 1600 BCE, and various ancient archaeological sites which, if studied meticulously, could yield a wealth of astronomical information. Furthermore, the *Parāśara Tantra*—which was published by this university about 12 years ago—discusses the winter solstice occurring at the *Dhaniṣṭhā* (*Śraviṣṭhā*) *Nakṣatra*. It details a solar *Nakṣatra* zodiac, defining the path of the Sun amongst the stars divided into 27 equal periods (the *Nakṣatras*), and discusses the Sun's location within these equal divisions. It covers planetary periods and the motion of Agastya (Canopus), a highly significant star for India visible in the southern sky (though invisible above a latitude of 37 degrees). While the Tamilians may claim Agastya as their star, it is fundamentally an Indian star!

Additionally, we have the *Āryabhaṭīya* of Lagadha, which employs the rule of three and includes fascinating mathematical concepts. These texts will be explored in greater detail.

Precession, Pole Stars, and Dating the Texts

A fundamental astronomical fact is the precession of the Earth's axis. As the axis rotates, if an imaginary line drawn from the Earth's axis to the sky intersects a star, that star is designated the Pole Star. Otherwise, the point is simply the North Celestial Pole. The Earth's axis traces a circle around the North Celestial Pole, perpendicular to the ecliptic plane, over a period of approximately 26,000 years. This incredibly slow motion serves as our greatest temporal indicator for ancient historical periods.

In 2800 BCE, the North Celestial Pole aligned with the *Śiṃśumāra* constellation, specifically its 14th star, known as *Abhaya Dhruva*. Adjacent to it is the star *Sunīti*, designated as the mother of Dhruva. These stars are explicitly named in both the *Taittirīya Āraṇyaka* and the *Brahmāṇḍa Purāṇa*. While these texts were published over 130 years ago, it was only 15 years ago that Indian scholars fully recognized the description of the star *Abhaya Dhruva* within the *Śiṃśumāra* constellation—known to modern astronomers as the constellation Draco, with the star identified as Alpha Draconis. We now know definitively that this was the Pole Star around 2850 BCE.

Naturally, this Pole Star has shifted over time. Today, the North Celestial Pole is aligned with the constellation Ursa Minor (Alpha Ursae Minoris). Indian astronomers referred to this constellation as *Dhruva Matsya*. Following the era of *Abhaya Dhruva* 5,000 years ago, there was a prolonged period (beginning roughly after 2300 BCE) where no bright star was situated near the North Celestial Pole. Consequently, when scholars like Āryabhaṭa or Brahmagupta discussed astronomy, they did not refer to a *Dhruva Tārā*; they spoke solely of the North Celestial Pole without a corresponding star. It is only over the last 400 to 500 years that a star within *Dhruva Matsya* (Ursa Minor) has closely approached the pole. By the end of this century, it will almost perfectly align with the North Celestial Pole.

Indian astronomers also documented that, after 500 to 600 years, the North Celestial Pole had drifted away from *Abhaya Dhruva*. They articulated this phenomenon as "*Dhruvasya Calanam*" (Dhruva is moving). This precise observation is recorded within our Vedic corpus and the *Maitrāyaṇīya Upaniṣad*.

The Pole Star in Rituals and Modern Indology

In more recent times, as modern Indologists began studying Indian texts, the German Indologist Hermann Jacobi analyzed the *Gṛhya Sūtras* and *Śrauta Sūtras*. He noted that *Dhruva Darśana* (viewing the Pole Star) is a prescribed ritual in traditional marriage ceremonies. The associated verses instruct the prospective husband to tell his wife: "This whole household will revolve around you like all these celestial objects revolve around Dhruva. You are the center of the household."

Jacobi reasoned that Indians must have actively observed a *Dhruva Tārā* when this ritual was formulated. Given that 19th-century astronomy confirmed the absence of a visible Pole Star from roughly 2000 BCE until recent centuries, Jacobi concluded that the *Gṛhya Sūtras* were referencing Alpha Draconis, the Pole Star of 3000 BCE.

However, his hypothesis was swiftly rejected by other Indologists within months. William Dwight Whitney countered almost immediately, asserting that there was no mention of Dhruva anywhere in ancient Vedic literature. Arthur Berriedale Keith, whose translations of texts like the *Taittirīya Āraṇyaka* remain standard in university curricula, similarly claimed that Dhruva was absent from the Vedic corpus. Yet, Professor Iyengar has since identified 30 to 40 instances of Dhruva explicitly mentioned in the *Ṛgveda* itself, while the *Taittirīya Āraṇyaka* clearly references both the *Śiṃśumāra* constellation and the *Dhruva Nakṣatra*.

This evidence rigorously pushes the chronology of Indian history back to the 3000 BCE period. While we need not claim the *Taittirīya Āraṇyaka* was literally composed in 2850 BCE, it accurately records the celestial memory of that era. Consequently, our recorded history should firmly integrate this 3000 BCE anchor point as a foundational element of our identity and the Vedic corpus. Unfortunately, even 15 years after this research was published, many historians continue to ignore this concrete evidence regarding the antiquity of Indian astronomy and culture.

Regarding the *Mahāsaṃhitā*, as Professor Rangarajan noted, the *Parāśara Tantra* is a profoundly ancient text referenced extensively in later astronomical and astrological literature. While no complete manuscript of the *Parāśara* texts was available, researchers painstakingly analyzed 25 available manuscripts of the *Vṛddha Garga*, identifying 11 that discussed this ancient astronomy within the *Vṛddha Garga Jyotiṣa*. This text comprises 64 parts called *Aṅgas* (the first 24) and *Upāṅgas* (the remaining 40). The critical 24th text, identified as the *Mahāsaṃhitā* and published about two years ago, was composed in majestic Vedic prose resembling the *Brāhmaṇas*.

It opens with an extensive dialogue where Maharishi Viśvāmitra asks Vṛddha Garga fundamental questions, akin to those a student might ask a teacher: "How did the sky

(*Antarikṣa*) and the Earth (*Pṛthvī*) manifest? How did the *Pañcabhūtas*, winds, and clouds originate? What is the nature of the Sun and Moon, their motion, location, and the cycle of day and night? What is the nature of the planets? Who is Rāhu, the cause of the eclipse? What are *Dhūmaketus* (comets)?" The first 22 passages pose these questions, followed by highly detailed answers that carry the signature of the astronomical frameworks later found in the *Parāśara Tantra*, the *Vṛddha Garga Jyotiṣa*, Lagadha's *Vedāṅga Jyotiṣa*, and subsequent texts.

The Indian Calendar and the Yuga System

The *Mahāsaṃhitā* concludes with the declaration that this *Jyotiṣa Aṅga* represents the supreme science (*Parama*). In contrast, late 20th-century Indologists like Pingree summarized the *Vṛddha Garga Jyotiṣa* by dismissively claiming that the 24th *Vedāṅga* merely dealt with rainfall. While rainfall forecasting is one of its many subjects, the text itself stands as one of the greatest treatises on ancient Indian natural science.

Because the *Parāśara Tantra* is not available in standalone manuscript form, scholars rely on two major sources where it is extensively quoted. One is the commentary by the Kashmiri astronomer and astrologer Bhaṭṭotpala. Bhaṭṭotpala authored commentaries on both the *Bṛhat Saṃhitā* and the *Bṛhat Jātaka* of Varāhamihira. (Post-Varāhamihira, the science of *Jyotiṣa* was formally divided into three branches: *Gaṇita Jyotiṣa* or mathematical astronomy, represented by the *Pañca Siddhāntikā*; *Jātaka* or horoscopy, represented by the *Bṛhat Jātaka*; and natural science, represented by the *Bṛhat Saṃhitā*).

In his commentary on the *Bṛhat Saṃhitā*, Bhaṭṭotpala cites Parāśara and Vṛddha Garga over 600 times. These quotations, alongside citations in a later 12th-century text called the *Adbhuta Sāgara* (compiled in Mithila by King Ballālasena), were consolidated by Professor Iyengar in 2013. This compilation features detailed discussions of the Sun's transit through the stars and the progression of the seasons.

The text maps the six major *Ṛtus* (seasons) to the *Nakṣatras* the Sun passes through. For example, when the Sun moves from the beginning of *Śraviṣṭhā* to the middle of *Pauṣṇa* (marking the winter solstice), the *Vasanta Ṛtu* begins. In this ancient framework, the winter solstice is explicitly identified with the beginning of *Śraviṣṭhā*. Taking the standard progression of the 27 *Nakṣatras* (*Aśvinī*, *Bharaṇī*, *Kṛttikā*, *Rohiṇī*, etc.), the solstice points have measurably shifted. I have located the solstices and equinoxes for 1300 BCE, placing the winter solstice at the beginning of *Śraviṣṭhā* and the summer solstice at the middle of *Āśleṣā*. Due to axial precession, the solstices and equinoxes slowly retrograde (move in the opposite direction) relative to the fixed stars. For instance, the vernal equinox, historically associated with the beginning of *Aśvinī* (or *Meṣa*/Aries around the time of Āryabhaṭa 1400 years ago), has now precessed to the beginning of *Pūrva Bhādrapadā*.

The texts also lay out mathematical tools, such as the Rule of Three (*Icchā Phala*): the known result is multiplied by the desired quantity and divided by the given quantity. This foundational algorithm ("If five bananas cost 27 rupees, how much will 27 bananas cost?") is explicitly detailed in the *Vedāṅga Jyotiṣa*. It became ubiquitous in Indian applied mathematics and only appeared globally as the "Golden Rule" of science some 600 to 700 years later.

Furthermore, the texts provide formulas for daylight length, noting 12 *Muhūrtas* of daylight on the winter solstice, increasing daily by 2/61 *Muhūrtas* until reaching a maximum of 18 *Muhūrtas* on the summer solstice. Western scholars have routinely claimed this 3:2 ratio originated in Mesopotamia. However, a 3:2 maximum-to-minimum daylight ratio does not mathematically align with the latitude of Mesopotamia (around 30 to 31 degrees), undermining the borrowing hypothesis.

By the Common Era, the mechanics of the Indian calendar were largely settled—a complex system rarely taught in modern schools. The Indian calendar is not purely conventional; it is fundamentally an observational calendar based on precise ephemeris readings (the *Pañcāṅga*).

There are two distinct measurements of the year. The sidereal solar year is the time taken for the Sun to traverse from one fixed point (like *Meṣa*) back to that exact stellar position. Its modern average period is 365.25636 days. Ancient Indian texts approximated this at roughly 365.258 days, showing slight error in the third decimal place. (We must be precise here: claims that Āryabhaṭa calculated the year accurately to five decimal places are historically inaccurate, and we should critically evaluate such statements, even when intended as praise).

Conversely, the tropical year measures the time between successive vernal equinoxes. The equinox is observationally verified by noting the sunrise moving from south to north along the horizon; the extreme southern point is the winter solstice, the extreme northern is the summer solstice, and the exact midpoint (when day and night are equal and the sun rises due east) is the equinox. Because the equinoxes precess, the tropical year and sidereal year differ by approximately 0.01 days—a margin that creates substantial calendar drift over centuries.

Alongside the solar year, the calendar integrates the lunar month, measured from *Amāvāsyā* (new moon conjunction) to *Amāvāsyā*, averaging 29.5306 days. Because 12 lunar months fall short of the solar year by about 11 days, the calendar must insert an intercalary month (*Adhika Māsa*) roughly once every three years (more precisely, 7 times in 19 years) to synchronize the lunar and solar cycles, a rule detailed in later *Siddhāntic* texts.

In practice, India utilizes three major regional calendar variations. Regions like Kerala, Tamil Nadu, Orissa, Bengal, Assam, and Punjab utilize a purely solar calendar commencing with the Sun's entry into *Meṣa*. Regions like Karnataka, Andhra, Maharashtra, and Gujarat begin the year on the *Amāvāsyā* immediately prior to the Sun's entry into *Meṣa*. Meanwhile, much of North India counts lunar months from *Pūrṇimā* (full moon) rather than *Amāvāsyā*. Despite these variations, all regions integrate *Tithi* and *Nakṣatra* data alongside solar transit.

Crucially, a severe misconception plagues modern public understanding. Even scientists conflate the *Uttarāyaṇa* (the northward turn of the Sun) with January 14th, and *Dakṣiṇāyaṇa* with July 16th. In reality, the solstices occur around December 21st and June 20th. The January 14th date marks the *Makara Saṅkramaṇa*—the Sun's transit into the sidereal zodiac sign of *Makara Rāśi*. Thus, the *Makara Saṅkramaṇa* and the actual winter solstice (*Dakṣiṇāyaṇa*) are separate astronomical events. Ancient texts and inscriptions clearly distinguished between the solstice events and zodiacal entry points—a distinction well-understood by astronomers until about 200 years ago, when popular *Pañcāṅga* simplifications began equating them.

Similarly, we must not conflate the Gregorian calendar's March 21st equinox with the Indian April 14th *Meṣa* entry (*Viṣu*). As observed at the Anantha Padmanabha Swamy Temple in Thiruvananthapuram, the temple's architecture is perfectly oriented to frame the Sun rising due East exactly on the true equinox of March 21st, not April 14th.

Returning to Lagadha's *Vedāṅga Jyotiṣa*, its central innovation was the *Yuga* system—a five-year cycle designed to synchronize 62 synodic lunar months with 67 sidereal months. While this was an approximation rather than a perfect mathematical relation, it served as a highly functional periodic calendar. When the calculated cycle inevitably drifted from empirical sky observations, administrators simply made minor ad hoc adjustments at the beginning of the next *Yuga* to realign the calendar.

Post-Vedic Astronomy: The *Siddhāntas* and Epicycles

Unfortunately, early Indologists deeply misunderstood this system. Encountering an approximated 366-day year in the texts, they dismissed it as meaningless and proof of extremely erroneous Indian observations, failing to grasp the continuous correction mechanism inherent to the *Yuga* cycle.

How did Indian astronomy evolve post-Vṛddha Garga? Moving to planetary theory (which is a major focus of *Siddhāntic* astronomy courses taught by scholars like Professor Ramasubramanian), we see immense sophistication.

Āryabhaṭa introduced celestial mechanics utilizing bodies called the *Śīghrocca* of Mercury and the *Śīghrocca* of Venus, located at their actual mean positions but utilizing their respective periods of revolution (225 days for Venus, 88 days for Mercury). He modeled the mean planets themselves as moving alongside the Sun with a one-year revolution.

To calculate the true planetary position, Indian astronomy applied two major corrections. First, the *Manda* epicycle accounted for orbital ellipticity (known in modern physics as the "equation of center"). Since the ancient world used geometric circles rather than ellipses, Indian astronomers mathematically compensated for the elliptical orbits by utilizing a secondary revolving circle (the epicycle). The second correction, the *Śīghra* epicycle, compensated for the geocentric observational perspective—a highly complex mathematical transformation unique to *Siddhāntic* astronomy.

If you examine the *Siddhāntic* epicyclic model, the entire system is strictly geocentric. Yet, its predictive power is phenomenal. The geometric vector (distance and direction) from the true Earth to the planet in the Indian geocentric epicycle theory is mathematically exact to the vector from the Earth to the true planet in the modern heliocentric model. It functions as a perfect mathematical transformation from heliocentric to geocentric coordinates, yielding longitudinal predictions that perfectly match modern empirical observations.

Furthermore, calculating planetary latitude (the planet's declination above or below the ecliptic) requires an accurate determination of the planet's distance from Earth. The *Āryabhaṭīya* correctly predicted these distances and subsequent latitudes. By contrast, the contemporaneous

Greek system formulated by Ptolemy (2nd century CE) relied on completely arbitrary planetary distances, rendering his latitude calculations wildly inaccurate.

To argue that Āryabhaṭa (5th century CE) simply borrowed Greek planetary theory requires one to believe that Indians not only imported Greek tables but somehow systematically identified and corrected all of Ptolemy's mathematical errors—including the Greek reliance on the flawed "equant" point—while maintaining the guise of derived knowledge.

Additionally, establishing these planetary parameters requires accurate, long-term observation of planetary longitudes. Babylonians and Greeks relied heavily on eclipses to determine longitudes, but eclipses only yield data for the Sun and Moon, not the planets. Therefore, accurate planetary longitudinal observation was practically impossible globally until a few centuries ago—yet it was accurately observed and tabulated in India by 400 CE.

Debates on Greek and Babylonian Origins

The debate regarding the alleged Babylonian and Greek origins of *Siddhāntic* astronomy persists among Indologists. Skeptics frequently point to texts like the *Romaka Siddhānta* without analyzing the primary source. The actual *Romaka Siddhānta* is heavily Indianized, relying on the Indian *Yuga* system (which has no Greco-Roman equivalent) and utilizing Āryabhaṭa's sine functions and Indian technical terminology.

To preserve the Greek-origin hypothesis in the face of Āryabhaṭa's superior accuracy, prominent European mathematicians like B. L. van der Waerden hypothesized that a mathematically perfect "pre-Ptolemaic" Greek theory was developed around 200 BCE, transmitted to India, and subsequently lost entirely in the West. Thus, the argument states that Āryabhaṭa was accurate merely because he faithfully preserved the "lost" correct Greek theory. As Pingree famously asserted, India's greatest contribution to science was ostensibly its role as a passive preserver of Greek heritage. This Eurocentric paradigm dominated Indological research until roughly a decade ago.

Pingree went to extraordinary lengths, writing three volumes attempting to prove that Indian astrological texts like the *Vṛddha Garga Jyotiṣa* were direct translations of Greek omen texts from 300-400 BCE. He argued that the *Yavana Jātaka* was translated specifically to prove direct Greek transmission. However, contemporary scholars like Mak have definitively demonstrated that the *Yavana Jātaka* is an entirely original Indian composition, bearing no relation to translated Greek omens.

Conclusion: A Call to Action

To effectively counter these narratives, we must study our own texts with scholarly rigor. While we have numerous commentaries on mathematical texts like the *Pañca Siddhāntikā*, critical academic commentaries on texts like the *Bṛhat Jātaka* or the *Vṛddha Garga Jyotiṣa* are virtually non-existent. The prevailing attitude—shared sadly by many traditional Indian scholars—has been to dismiss them as mere "astrology texts" unworthy of academic study, leaving them to commercial astrologers.

In contrast, European scholars spent the last 150 years meticulously compiling, translating, and analyzing the omen literature of Europe, Arabia, and India to construct a narrative of linear transmission from Mesopotamia to Greece to India. Our failure to independently study and assert our own literary tradition has left us uniquely vulnerable to these historical appropriations.

Q&A Session

Audience Member: Sir, I have a question. Was the concept of *Rāśis* (zodiac signs) and predictive astrology originally an Indian concept, or are there Western influences?

Prof. Srinivas: The *Vedāṅga Jyotiṣa* had a highly specific, limited purpose. Indologists often point to the *Romaka Siddhānta*, which utilizes a tropical year of exactly 365.25 days and a cycle of 19 solar years to 12 lunar months, as evidence of Greco-Roman importation. In truth, we do not have a complete picture. Extant fragments of the *Romaka Siddhānta* are entirely formatted within the Indian mathematical paradigm, utilizing Āryabhaṭa's sine functions and Indian technical vocabulary. Even if certain parameters were imported, they were thoroughly integrated and adapted by Indian scholars into the existing Indian astronomical framework.

Regarding Varāhamihira, the lack of multiple critical manuscripts makes establishing the exact conceptual provenance difficult. The most frequently cited evidence for Greek influence in the entire Indian astronomical corpus is a single verse by Varāhamihira in the *Bṛhat Saṃhitā*:

"*Mlecchā hi yavanās teṣu samyak śāstram idaṃ sthitam / ṛṣivat te'pi pūjyante...*"

(The Greeks are *Mlecchās*, but this science is well established among them, so they are honored like sages.)

While texts like the *Yavana Jātaka* and *Vṛddha Yavana Jātaka* emerged in later traditions, they are not direct translations of Greek or Roman works, even if they share certain conceptual elements.

During the Mughal period, *Tājik* and later *Romaka* works were translated into Sanskrit. However, regarding foundational mathematical astronomy, there is virtually zero direct translation from foreign sources into Indian texts. Conversely, the massive volume of Indian astronomy translated into Arabic remains grossly understudied. Foundational European astronomical texts, such as the Toledo Tables and the Alfonsine Tables (created in Spain and pivotal in the transition to the Gregorian calendar), are directly derived from Indian mathematical concepts transmitted via Arabic!

If one wishes to categorise these texts as foreign, the academic burden of proof requires locating the specific source texts, performing comparative analysis, isolating the shared concepts, and identifying specific textual citations. Until that rigorous comparative work is done, dismissing original Indian literature as derivative translations remains academically unfounded.

Lecture of Prof. R. N. Iyenger (1)

Primary Sources of Indian Astronomy

All of us know how knowledge has been transferred in this country. In the earliest period, it was exclusively a *Guru-Śiṣya* (teacher-disciple) kind of *paramparā* (lineage). It was an oral tradition. It is still a development of knowledge, but it was fundamentally oral.

The primary concepts of this tradition will be discussed in detail as we examine the *Mahāsalila* text. In the *Mahāsalila*, this is formally explicitly stated, but the concept permeates the entirety of the Vedas. What is that concept? It is a tripartite framework. The entirety of this universe comprises three components, so to speak. The universe includes, as far as we earthly beings are concerned, the *Dyau*, which is the celestial and the astral realm, whatever you see at the top. Second is *Pṛthvī* itself; where we are currently living is the *Pṛthvī*. There are profound nuances to these words, and later on, you will see how they operate as technical terms.

It is important to clarify this, because we generally take *Pṛthvī* to mean Earth, that is, *Bhūmi*. This is correct, but in the earliest conceptualisation, *Pṛthvī* referred to something expansive, something which had widened. Thus, the earliest cosmographic or cosmogonic concepts were somewhat different. Slowly, the specific concept of *Bhūmi* emerged. *Bhūmi* is included within *Pṛthvī*, but *Pṛthvī* is a much broader concept. You must keep this in mind. Today, when we say *Pṛthvī*, we mean only *Bhūmi*—only the Earth. So, one must maintain a degree of flexibility and conceptual resilience regarding these terms.

And then there is the intermediate sphere, the *Antarikṣa*. *Antarikṣa*, as the word itself indicates, is something that is in-between. There are several definitions given for the word *Antarikṣa*, which we will explore later. Essentially, whatever exists between the *Dyau* and *Pṛthvī* is the *Antarikṣa*. It is akin to open space. Does it mean that the entirety of *Dyau* is also space, or is it not space? These concepts initially appear hazy. Just as when you look up at the sky and see something hazy, these early astronomical ideas are also somewhat hazy, but you will see how precise new concepts slowly emerged from them.

Deities, Etymology, and the Vedic Universe

Now consider the *Nirukta*, a text that generally belongs to the *Vedāṅga* period. Because this is an introductory lecture, I am not going into the deepest specifics—we will come to those later. A question frequently arises: how many gods are there? How many *Devas* are there?

Are there three *Devas* or only one? Regarding monotheism, many people will argue, "No, there is only one god." That concept does not neatly apply here; let us be very clear. When the word *Deva* is used, it is often translated into English as 'gods' (with a lowercase 'g'). Some will argue that a capital 'G' signifies something different, and that in the Vedic concept, we should use the lowercase 'g'. I find this inadequate. If you understand it conceptually, that is fine, and I have no objection, but it remains imprecise. The reason is that Yāskācārya, who lived approximately 1000 BCE—or perhaps even earlier—asks in one place, "Are there 33 *Devas*?" We all know that 33 is the commonly cited figure: 33 gods.

Some propose that the 33 gods correspond to the 28 *Nakṣatras* plus the 5 planets, making 33. Others will counter, "No, that is incorrect; Hindus did not know about planets in the Vedas, so

it must represent something else." Let us not delve into those debates right now. Some will ask, "Why only 33? They had a much larger number; 3,339 is a figure that occasionally appears." I am going to talk about that tomorrow. There are many *Devas*. Even in the *Purāṇas*, you will find differing accounts, such as in the *Brahmāṇḍa Purāṇa*. It is not that they did not know the Veda; we will discuss how that evolution happened as well.

It is crucial for this course to acknowledge that there have been numerical errors during the historical copying of texts, particularly in the Purāṇic period. Fortunately, the numbers that have come down to us from the Vedic period seem to be *pakkā*—they appear perfect and robust. Many of them can also be interpreted in a highly rational or logical manner, utilizing methodologies not unlike the systems of *Nyāya* or *Pramāṇa*.

Yāska, in the *Nirukta*, asks why we must resort to all of this complexity when three are sufficient. Three *Devas*, representing three fundamental principles, are enough. What about the others, then? He explains that the multitude of others arise due to their varying actions. He offers an analogy: consider a director with several subordinates; they all belong to the same office. There is only one overarching office, but because of the distinct actions they undertake—due to *adhikāra bhedāt* (difference in jurisdiction or duty)—you have different desks, different subordinates, and distinct roles. Thus, you can have a multitude of *Devas* functioning in this manner. This is his argument, asserting that three core principles are fundamentally sufficient.

Now you understand the origin of this concept. It serves to explain the overall operating principle of the universe, or the cosmos. Therefore, the fundamental objective in the Vedic period, at least concerning our study, was the systematic explanation of the universe. How did they achieve this? What elements were necessary to construct this explanation?

What is that universe? We are considering the visible universe, not the mental or psychological realm. That is a separate philosophical matter which I will not delve into here. However, peculiarly enough, by the end of this workshop, you will see that these realms are all inherently interconnected—the psychological, the physical, and another intermediary domain with which we are very familiar. We often assume that the Vedas and Vedic astronomy are entirely concerned with *Yajñas* (rituals). You have likely heard that rigorous timekeeping was necessary merely to schedule *Yajñas*. That concept has indeed continued in Indian astronomy, particularly in *Phalita Jyotiṣa* (predictive astrology), where *purohitas* fix auspicious times using the *Pañcāṅga* and similar tools. I am not exploring that ritualistic aspect at all. But the foundational scientific principles from which it all started are rooted right here.

Yāska further states that when it comes to Vedic interpretation, the framework must adapt because everything requires an explanation. If there are only three primary *Devas*, what about Indra, Sūrya, Agni, Vibhāvasu, and the myriad others that appear? Explanations exist for many of them. If you look at the *Bṛhad Devatā* text—though I will not go into detail—it catalogs something like 720 *Devatās*. However, these are fundamentally just names.

You all understand that to identify something, you need a name. Why do you name an object a certain way? This is something to ponder. It is for identification. But how does this

identification often occur? Perhaps someone is stout, someone is beautiful, or someone is lean. Many words simply refer to a specific defining quality. In Sanskrit grammatical terms, the *guṇavācaka* (the adjective or quality-indicator) itself functions as the *nāmavācaka* (the noun or name indicator). The observed quality becomes the name.

In fact, if you examine the Vedic *Bhāṣya* (commentary), it explicitly states—and I will provide exact references for this later—that one entity can possess different names based on different actions. A person is a single individual, yet they may hold multiple functional titles. Similarly, different entities can share the same name if they are performing the identical action. What is logically inconsistent about that? When interpreting the Veda, we frequently encounter these linguistic issues, particularly concerning astronomical bodies and forces.

This is especially true when we discuss the concept of a *Deva*. Today, we associate *Devas* purely with worship—keeping an icon, chanting mantras, and performing *pūjā*. This is entirely acceptable; after all, it is a derivative of the ancient *Yajñas*, distilled over time through the *Gṛhya* and *Śrauta* traditions. We will touch upon this later. The point is, we must keep this intellectual background in mind and avoid rigid modern conceptualizations. We must remain flexible. We should accept these possibilities not merely because I or someone else suggests them, but because Yāska himself rigorously established this framework millennia ago.

Imagine the state of our knowledge today. Whether derived from the *Ṛgveda*, *Yajurveda*, or *Sāmaveda*, whether tied to a specific *gotra*, South Indian custom, North Indian custom, or Saraswat traditions—it has all passed through a historical filter. It is much like the river Gaṅgā: it has one color near Haridwar and a distinctly different color by the time it reaches Kanpur. We are in a similar situation regarding our heritage. Whatever knowledge we possess today has flowed through centuries of intellectual filters.

The Historical Timeline of Indian Astronomy

Even before we examine texts like the *Mahāsalila* or the *Parāśara Tantra*, we must recognize that this astronomical knowledge has flowed through the *Śrauta* manuals, the *Brāhmaṇa* texts, the *Saṃhitās*, the *Upaniṣads*, the *Kalpa Sūtras*, and the *Vedāṅgas*. It has been filtered through these corpora, and this is largely what is reflected in subsequent classical literature. Whether it be Pāṇini's grammar or the *Mahābhāṣya*, we will examine some of these references. Our understanding of pre-Common Era astronomy must be carefully situated within this textual perspective.

Therefore, it is critical to at least know the names and scopes of these texts. What subjects do they cover? I have listed the core subjects here: *Dyau* (heaven), the sky, water, cosmology, cosmogony, astronomy, stars, *Dhruva* (the pole), the Sun, Moon, planets, eclipses, comets, and meteors. All of these are systematically documented in the Vedic texts in some manner. Yes, a question?

(Audience Question: What is the difference between cosmology and cosmogony?)

Cosmology and cosmogony. As I understand it, cosmology is the broader, more general term. Cosmogony specifically deals with genesis—how the universe and celestial bodies originated

and were born. Cosmography, on the other hand, deals with the physical geometry and spatial mapping of the cosmos. Cosmology encompasses all of these and more. Cosmography is clearly present in our texts, particularly in the geometric descriptions of Mount Meru, which we will discuss later. Cosmogony is also present in the Vedas themselves, detailing narratives of how *Śukra* (Venus) or *Aṅgāraka* (Mars) were born. Thus, all these distinct conceptual frameworks are embedded in the literature.

Regarding eclipses, comets, and meteors: Professor Srinivas mentioned the Atri eclipse this morning. We will cover all of that. Then we have the *Antarikṣa*, which corresponds to what we today call the atmosphere. It encompasses wind, clouds, monsoons, seasons, rainfall, rainbows, halos, lightning, and thunder. While phenomena like thunder may not dominate popular astronomy today (though atmospheric physicists certainly study it), in ancient times, it was considered a deeply significant and measurable phenomenon. Thus, all these elements are vital components of pre-*Siddhāntic* astronomy.

Moving down to *Pṛthvī*, this represents our day-to-day life on Earth. This sphere encompasses language, agriculture, oceans, earthquakes, mountains, geography, religion, art, culture, *Vāstu* (architecture), *Śilpa* (crafts/sculpture), calendars, mathematics, geometry, and measurement. These three spheres—*Dyau*, *Antarikṣa*, and *Pṛthvī*—are universal and continuous across all cultures and times. All of these subjects are already present, in some foundational form, in the pre-*Siddhāntic* period. We will touch upon many of them, as our study of before Common Era astronomy is intricately linked to these domains.

I am now going to project a schematic representation. Why is this important today? Why is the IKS (Indian Knowledge Systems) division promoting this? If we are to succeed in integrating an Indic ethos within the NEP (National Education Policy)—a goal frequently discussed across various political and educational platforms—we must profoundly understand these historical foundations.

I have projected a timeline here. It extends back before 3000 BCE. Key markers are placed at 1500 BCE, 500 BCE, 1300 CE, and 2000 CE. We are currently right here. I am being specific because there is a popular, simplistic narrative suggesting that simply reverting to the *Gurukula* system will automatically restore all ancient knowledge. Many initiatives make such claims. I will not critique those directly.

From my perspective, oral Vedic learning originated deeply in antiquity. This Vedic tradition was fundamentally based on empirical, observational knowledge; it was a rigorous scientific tradition. What defines science? It means that others can verify, reproduce, and comprehend the knowledge. When a *Guru* imparts a lesson, the *Śiṣya* (disciple) must eventually be able to say, "Yes, sir, I have observed and understood." This empirical dialogue is visible throughout the *Upaniṣads*. This is science; this is the true tradition.

Around 1500 BCE, significant changes diverged from the pure Vedic oral tradition. On this timeline, you see a continuous horizontal line representing the oral Vedic tradition continuing up to the year 2000 CE. Even today, this oral tradition survives. In Bangalore, or anywhere across India, you will find Vedic *Gurukulas*. What is their primary function? They precisely

recite and preserve the Vedas exactly as it was done millennia ago, learning *guru-mukhena* (directly from the teacher's mouth). The oral tradition continues unbroken.

Thus, we have two distinct trajectories. The intellectual, analytical tradition branched off roughly around 1500 BCE. What emerged from this? We saw massive theoretical developments. First, the *Vedāṅga* tradition, followed around 500 BCE by the flourishing of Vedic, Buddhist, and Jaina philosophies. These combined intellectual traditions all originated from the same primary oral Vedic flow—from the source river, so to speak. They grew exponentially and virtually exploded into a golden age of systematization around the Common Era. The period from 500 BCE to 800 CE can be considered the absolute pinnacle of intellectual development in Indian history. All of this innovation stemmed directly from that foundational oral tradition.

Moving forward to the 1400s CE, we observe the tragic collapse of great institutional universities like Nālandā and Vikramaśīlā. Following this, I have charted a period of deterioration—deterioration in a broad, cultural and institutional sense, rather than a strictly quantitative one.

It is worth noting that UNESCO recognized the Vedic oral tradition as an Intangible Cultural Heritage of Humanity in 2008. While terms like ITK (Indigenous Technical Knowledge) are often used, this specific recognition of the living oral tradition is highly significant. By contrast, in 2016, the ruins of Nālandā were recognized as a tangible heritage site. Nālandā remains today only in static brick and stone. I am not minimizing that architectural importance; recognizing sites like Harappa or Mohenjo-daro is vital. However, there is a profound difference between preserving a physical architectural site and preserving a living, unbroken cognitive heritage.

Looking at this chart, the oral tradition continues. The goal of the modern university system, and explicitly the NEP, is to bridge these two streams—to reconnect the analytical intellectual tradition with the living oral tradition. The oral tradition may continue as it has, or it may decline; its future is uncertain. I am merely presenting this historical trajectory, not passing judgment.

It is also crucial to note that even during periods of apparent institutional decline, brilliant mathematical advancements occurred. As Professor Srinivas mentioned this morning, some of the most advanced mathematics—the Kerala school, infinite series, early calculus—developed between 1400 and 1800 CE. This was an exceedingly difficult era, particularly for South India, marked by the fall of the Vijayanagara Empire and the battle of Talikota. Yet, we must ponder how such tremendous intellectual milestones were achieved during such turbulent times. This resilience is a core part of our past and tradition.

The most comprehensive commentary on the Vedas was authored in the 14th century. If you wish to extract astronomical knowledge from the Vedic background today, what is your primary source? First and foremost, it is the *Sāyaṇa Bhāṣya*. Although titled the *Sāyaṇa Bhāṣya*, it was not authored by Sāyaṇa alone. He led a syndicate of 32 scholars summoned from across India. It was a turbulent era, yet the ruling monarchs (Harihara and Bukka of the Vijayanagara

Empire) supported him, recognizing that codifying this knowledge was essential for the survival of the culture and tradition. They granted land (*jāgīrs* and *agrahāras*) near Śṛṅgeri and other regions to sustain this monumental effort. This is the textual corpus we rely on today.

To deeply engage with the Vedic texts, you must navigate through these historical pillars. One is the *Nirukta* from approximately 1000 BCE; the other is the relatively recent *Sāyaṇa Bhāṣya* from 600 years ago. There are intermediary commentaries as well, such as that of Bhaṭṭabhāskara, which we will also examine.

I emphasize this because if the NEP is to succeed—if the ancient intellectual tradition is to be successfully integrated with the modern university system—we must be highly practical. We cannot simply erase the modern university system and revert everything to *Gurukulas*. That is unrealistic. The two systems must converge. To achieve this, we must look to historical precedents, just as the Vijayanagara kings patronized Sāyaṇa to consolidate knowledge. The Government of India is currently interested in this integration, and it is our academic duty to rigorously investigate what scientific data exists within the Vedas to the best of our abilities.

This integration is the primary motivation for this workshop. Please keep the trajectory of this timeline in mind. Merely constructing a new Nālandā Mahāvihāra and investing crores of rupees in infrastructure will not magically revive the intellectual tradition. You can construct beautiful buildings and name them the Varāhamihira Centre or the Cāṇakya Centre—ironically, they are rarely named after Vṛddha Garga or Parāśara, largely because these foundational figures are unknown to the planners, which is highly unfortunate.

Overview of Vedic Texts

Let us formally review the texts themselves. Following this introduction, it is necessary to outline the literature we will be utilizing. You have all heard of the four Vedas: the *Ṛgveda*, *Yajurveda*, *Sāmaveda*, and *Atharvaveda*.

Structurally, these Vedas are subdivided. At the core are the *Saṃhitās*, followed by the *Brāhmaṇas*. Within the *Brāhmaṇas*, there are substructures known as the *Āraṇyakas* and the *Upaniṣads*. Some scholars argue that classifying a text strictly into *Saṃhitā* and *Brāhmaṇa* is sufficient, as the *Āraṇyakas* and *Upaniṣads* are technically embedded subsets of the *Brāhmaṇas*. For our purposes, this is a minor taxonomic detail.

It is worth noting that rigorous textual criticism has shown that many *Upaniṣads* available today contain later interpolations. However, we need not worry about that, as our focus remains solely on extracting data from the most ancient strata of the texts. Do not worry; we are not going to study the entirety of this corpus—that would require a lifetime. However, you must understand the classification.

Starting with the *Ṛgveda Saṃhitā*, the primary recension available today is the *Śākala Saṃhitā*. While others existed, they are largely lost. There is an *Āśvalāyana* recension available, though it remains understudied, as well as a *Bāṣkala Saṃhitā*. For each *Saṃhitā*, there are corresponding *Brāhmaṇa* texts. For example, attached to the *Ṛgveda* are the *Aitareya*

Brāhmaṇa, *Aitareya Āraṇyaka*, and *Aitareya Upaniṣad*. We will be specifically examining the *Aitareya Brāhmaṇa*, as it contains relevant astronomical data.

Similarly, we move to the *Yajurveda*, an incredibly important text. As many of you know, the *Yajurveda* is divided into the *Kṛṣṇa* (Black) *Yajurveda* and the *Śukla* (White) *Yajurveda*. Broadly speaking, the *Śukla Yajurveda* is practiced predominantly in North India, while the *Kṛṣṇa Yajurveda* is practiced more in South India. This is an enormous text, widely available in print. Within the *Kṛṣṇa Yajurveda*, you have various *Śākhās* (branches).

(Host: We will take a break soon...) All right, we will break for tea shortly. Let me just finish this section. Within the *Kṛṣṇa Yajurveda*, we have the *Taittirīya Saṃhitā*, *Taittirīya Brāhmaṇa*, and *Upaniṣad*. We also have the *Maitrāyaṇīya Saṃhitā* of the *Kṛṣṇa Yajurveda*, which is available and will be referenced in this course. Additionally, there are the *Caraka* and *Kaṭha Śākhās*. The latter two are essentially no longer practiced in India today. There is reportedly a small community of *Maitrāyaṇīyas* near Nashik, though I have only read about them and not met them. *Taittirīyas*, however, are abundant in the South—in Karnataka, Tamil Nadu, and parts of Maharashtra. *Ṛgvedis* are found all over India. When I say 'practiced,' I mean the oral recitation tradition is actively continuing. I mention this not out of vanity or cultural pride, but as an empirical fact: the *Taittirīya* and *Ṛgveda* traditions remain unbroken.

Similarly, certain branches of the *Sāmaveda* are still practiced. The *Sāmaveda* possesses the largest number of *Brāhmaṇas*, which contain significant astronomical information. I will refer to some of this briefly, but much of it represents excellent potential research projects for you to take up later. The *Sāmaveda* has two primary extant branches: the *Kauthuma* and the *Jaiminīya*.

Finally, we come to the *Atharvaveda*, which also has two main branches: the *Śaunaka* and the *Paippalāda*. Historically, one was practiced more in Kashmir and the other more in Odisha. Western scholars, such as Michael Witzel, have done extensive work locating, editing, and publishing these manuscripts. The *Atharvaveda* is highly important to us; it contains vast amounts of information, not only on Vṛkṣāyurveda (botany) and medicine but also on astronomy.

Lecture of Prof. R. N. Iyengar (2)

Analysing the *Mahāsalila* and the Role of *Vyākaraṇa*

This analysis demonstrates that *vyākaraṇa* (grammar) is explicitly utilized within the *Mahāsalila* for astronomical purposes. Analysis is a fundamental component of this study; as is widely known, Pāṇini's *vyākaraṇa* is primarily an analytical framework. Furthermore, *chanda* (meter) is essential. We observe that the Vedas themselves are referred to as *chandas*, and these meters are crucial for time measurement—a concept derived directly from the Vedas. *Nirukta*, as previously discussed, deals with etymology and the origin of words. Next, we consider *Jyotiṣa*, which is our primary focus.

While it is true that these disciplines are *Vedāṅgas* and *Jyotiṣa* is explicitly a *Vedāṅga*, the question arises: which specific text qualifies as a *Vedāṅga* text? For instance, texts like the *Bṛhat Saṃhitā* or the *Yavana Jātaka* cannot be classified as *Vedāṅga Jyotiṣa*. Even the works of Āryabhaṭa or Brahmagupta are classified as astronomical *Siddhāntas*, and they do not refer to themselves as *Vedāṅga Jyotiṣa*. However, *Jyotiṣa*, concerning astronomical or celestial objects, is inherently *Vaidika* (Vedic). It is undoubtedly a part of the Vedas. Yet, academically, we must differentiate generalities from specific texts. Therefore, which texts can definitively be called *Vedāṅga Jyotiṣa*? Lagadha's work is the well-known example. Our argument posits that the *Parāśara* and the *Mahāsalila* (a section of the *Vṛddha Garga*) should also, at the very least, be classified as *Vedāṅgas*. The methodology for determining what constitutes a *Vedāṅga* will be addressed subsequently.

Vedic *Yajña*, Rituals, and Earthly Connections

There is a prevailing scholarly view that the Vedas are exclusively intended for conducting *yajña* (rituals). Consequently, both pre-modern and modern scholars in India have predominantly focused their studies of Vedic mantras on their ritualistic elements. However, this represents only the *adhidaivika* (divine or celestial) aspect of Vedic interpretation. It raises the question: what of the *adhibhautika* (physical or material) interpretation?

The scope extends beyond the *adhidaivika*. The *bhautika* aspect pertains to the *pṛthvī* (earth). Evidence of this earthly connection is present; prior discussions have highlighted references to earthquakes, rainfall, and similar terrestrial phenomena. A fundamental Vedic principle is that these elements are not disjointed; they are intricately connected. Whether one categorizes rainfall as an atmospheric or earthly phenomenon depends on the observer's perspective. For an agriculturalist, the impact on the earth is paramount, whereas a scientist may prioritize the atmospheric origins.

The Ritualistic Bias in Translating the Vedas

The approach to studying Vedic texts is a subject of ongoing academic debate. The eminent Vedic scholar Satya Shrava astutely pointed out a significant limitation in the trajectory of Vedic studies in India. In his literature (similar to the work of S.B. Dixit), he argues that the interpretation of hymns has been disproportionately confined to their ritualistic significance. This trend dates back to the medieval period, notably the era of Sāyaṇa, whose influential works

became readily accessible to Western scholars. This accessibility filled a narrative void but perpetuated a specific bias.

It established the paradigm that the hymns are exclusively meant for ritualistic *yajñas* (*"Vedā hi yajñārtham pravṛttāḥ"*). Sāyaṇa himself articulated this view in his preface to the *Taittirīya Saṃhitā*. Consequently, translations of the Vedas and the subsequent scholarly literature based upon them must be viewed as one-sided and incomplete. This underscores the assertion that interpreting the Vedas solely through a ritualistic lens—the prevalent method of translation, pedagogy, and popular belief—is fundamentally restrictive.

Conversely, a comprehensive interpretation must account for the *devatā* (deity or core concept), the meter, and other structural elements. One must question the identity of the *devatā* and the necessity of the specific meter employed. In Vedic literature, a threefold framework for interpreting hymns is prescribed by Durgācārya, echoing the principles laid out by Yāska in the *Nirukta*. The *Nirukta* delineates three dimensions of interpretation: *adhyātma* (spiritual/self), *adhidaiva* (celestial/divine), and *adhiyajña* (ritualistic). As the text states, *"mantrāṇām arthā vijñāyante"* (these are the recognized ways the meanings of the mantras are understood). While Durgācārya, who composed a *vṛtti* (commentary) on Yāska's work, is a relatively recent figure, the chronological gap between him and the original Vedic texts spans millennia. We are attempting to retrieve astronomical knowledge from before the Common Era (BCE), which inherently involves addressing anomalies, scholarly dissatisfaction, and textual errors. Despite these challenges, advancing this research is crucial for recovering pre-BCE astronomy.

Three Cosmic Spheres and the Concept of *Devatā*

As noted, the *Nirukta* emphasizes the need to "explain the *devatās*." Regarding the *adhidaivata* aspect, the term *divya* is defined as *divyāḥ divijātāḥ* (that which is born or originates in the sky). Thus, a phenomenon "born in the sky" could refer to a parhelion, a halo, a celestial object, a star, or transient events like comets and meteors. It encompasses literal, observable phenomena in the visible sky. The root *div* signifies "shining," from which these terms are derived, associating the *devās* or the divine with the luminous celestial sphere.

While the Sanskrit terminology may seem dense, it is foundational to this study. The seventh chapter of the *Nirukta*, known as the *Devatā Skanda*, is dedicated to elucidating the Vedic *devatā*. This section reveals that the concept of a *devatā* is numerically based. A *devatā* may be classified numerically: *eka-daivatyā* (single deity), *dvi-daivatyā* (dual deities), or *bahu-daivatyā* (multiple deities). These numerical categorizations, also found in the *Bṛhad Devatā* (available in translation by Lakshman Sarup), are a critical concept to remember.

As established, the *Nairuktas* (etymologists) posit a minimum of three primary deities, representing three distinct cosmic spheres. *Agni* governs the earth, *Vāyu* (or *Indra*) governs the atmosphere, and *Sūrya* governs the heaven (*dyau*). This reflects the philosophical principle of *lāghava* (parsimony or elegance in brevity), a concept favored by both *Naiyāyikas* (logicians) and *Vaiyākaraṇas* (grammarians), encapsulated in the phrase *ardha-mātrā lāghavam*. Three is

the irreducible minimum to explain the cosmos, a concept completely distinct from modern notions of monotheism or polytheism.

Each of these primary deities receives numerous appellations based on their super-eminence or diverse functions. Analogous to a single priest functioning as the sacrificer (*Hotṛ*), the director (*Adhvaryu*), the processor (*Brahma*), or the chanter (*Udgātṛ*), a deity's panegyrics (*stotras*) and appellations reflect its multifaceted roles. Alternatively, these roles may represent distinct entities performing a shared function.

This framework necessitates analyzing group activity. *Yajñas*, for instance, are communal endeavors. The "community of employment"—the interaction between men, gods, and the earth—must be noted. The texts describe a "community of enjoyment," wherein the earth, clouds, air, and sun interact collaboratively. The macrocosmic sky mirrors the microcosmic kingdom of man on earth. Older Sanskrit texts describe the *sambhoga* (enjoyment or interaction) between the sky and the earth, frequently conceptualizing rainfall through metaphorical terms like the *vṛṣaṇa* or *vṛṣabha* (bull) releasing its seed downwards. These represent natural phenomena and interactions, emphasizing that cosmic forces and human actions are part of a shared, participatory framework.

Addressing a common query regarding the *Nirukta's* assertion of "only three *devatās*" (*tisra eva devatāḥ*) in contrast to the numerous *devatās* mentioned in the *Ṛgveda*: The *Nirukta* specifies three as the fundamental minimum required for cosmic explanation based on location. However, due to the diversity of actions, a primary deity like Agni can have subordinates, twins, or siblings. A single action can be executed collectively by many. Thus, the intellectual theorization defines three core principles, while the ritualistic and explanatory traditions incorporate a broader community of actors. This communal aspect is central to ritualistic practices and provides crucial context for understanding early astronomical observations.

The Threefold Cosmos and the Search for Vedāṅga Astronomy

The preceding passages clarify that the role of a *devatā* is to represent or govern a particular natural phenomenon. A minimum of three is required to represent the three fundamental locations: earth, atmosphere, and heaven. However, accounting for diversity in action, location, interaction, and time, the count may extend to thirty-three or more. This represents an early system of quantitative categorization. The sky is conceptualized as analogous to human society on earth.

Satya Shrava elaborates on this, noting that over centuries, as documented in the *Brāhmaṇa* and *Sūtra* texts, the rituals reached a "steady state." In this established context, explicit sky observations were rarely documented because they were assumed to be foundational knowledge held by the priests—knowledge that has largely been lost today. It is the *adhidaivata* interpretation that yields critical clues for decoding the Vedic sky.

A profound insight emerges: specific names, entities, concepts, and principles are requisite to articulate the Vedic cosmological worldview. The *Ṛgveda* contains complex societal and natural descriptions—kings, queens, diverse animals, and specific numerical values.

Misinterpretations frequently arise when these terms are taken too literally or translated out of context. For example, translating terms like *aśva*, *vājī*, or *hari* merely as "horse," relying on later lexicons like the *Amarakośa* which treat them as strict synonyms (*paryāya pada*), can lead to anachronistic historical conclusions (such as debates surrounding the Aryan invasion theory or the presence of horses in Harappan archaeology). Such confusion stems from a failure to comprehend the nuances of this intellectual heritage. To accurately extract scientific meaning, this tradition must be rigorously studied rather than merely memorialized.

Moving beyond the Vedic period to the post-Vedic BCE era, texts such as the *Saṃhitā* and *Brāhmaṇa* emerge. Extant literary references indicate that texts like the *Parāśara*, *Vṛddha Garga*, and Lagadha's *Vedāṅga Jyotiṣa* belong to the pre-Common Era, with their dates corroborated by independent methodologies. While the precise dating of the Vedas (e.g., 1200 BCE versus 3000 BCE) remains debated, their pre-BCE status is undisputed. The chronology of subsequent texts has been complicated by external historical narratives, resulting in a loss of the internal, or "emic," perspective.

Alongside Sanskrit literature, other linguistic traditions offer valuable data. The *Sūrya Prajñapti*, an astronomical text written in Prākṛta belonging to the Jaina tradition, shares fundamental similarities with Vedic astronomy, as does the Buddhist text *Śārdūlakarṇāvadāna* (which was translated back into Sanskrit from Chinese). Furthermore, classical dramas by Bhāsa (circa 300 BCE) and the *Arthaśāstra* (a pre-BCE text predating the use of weekdays and *rāśis* or zodiac signs) contain pertinent astronomical information.

The *Purāṇas*, including the epics *Mahābhārata* and *Rāmāyaṇa* (which contain extractable astronomical data and are generally considered pre-BCE in their historical core), represent a mixed corpus. Specifically, the *Brahmāṇḍa Purāṇa* and the *Vāyu Purāṇa* are critical. They are structurally concise and contain layers of information closely aligned with the Vedic period, such as references to the *Makhādi* era and equinoctial full moons. The *Brahmāṇḍa Purāṇa*, for instance, outlines a comprehensive theoretical model known as Meru-centric astronomy, which warrants rigorous scholarly extraction and analysis. Therefore, a thorough study of the Purāṇic corpus is indispensable for understanding pre-*Siddhāntic* astronomy.

Restructuring the Understanding of Indian Astronomy

A recurring academic question concerns the alignment of these textual findings with archaeological excavations of the Harappan civilization, an issue of dating that requires dedicated chronological analysis in subsequent lectures.

The development of Indian astronomy from the *Siddhāntic* period onward is well-documented. However, this formal framework does not encompass the entirety of India's astronomical heritage. There exists a rich stratum of folk and cultural astronomy—the sky as observed by the Harappans, the Vedic peoples, and various ethnic groups such as the Gonds, Bhils, and Nagas. This cultural astronomy, encompassing their understanding of the sun, moon, and stars, forms the true foundation for an integrated, scientific Indian Knowledge System (IKS).

A critical reassessment of the methodology used in Vedic studies is necessary. Currently, there is a risk of rendering the Indian Knowledge System into a caricature—reducing it to superficial postures, sculptures, and tantrism without rigorous intellectual checks and balances from the source civilization itself. This leads to a loss of profound cultural identity.

The objective of this academic endeavor is to introduce and consolidate ancient literary sources, including major and minor Vedic texts, early Purāṇas, and the *Parāśara* and *Vṛddha Garga* contexts. By consolidating the astronomical knowledge of the pre-Common Era, we aim to delineate its general properties and establish a rigorous sourcebook for scholars and IKS enthusiasts to propagate further.

The Foundational Concepts of the Rigveda: Sky, Directions, and the Equator

To introduce the foundational concepts of the *Ṛgveda*, we must attempt to understand the highly specific perceptual framework of the Vedic people, which, while peculiar from a modern standpoint, was the most natural way of viewing the world in antiquity.

Regarding the accessibility of these texts: the Vedas are open for universal study. The traditional restrictions (the *adhikāra* for *adhyayana* and *adhyāpana*) were historically applied to the specific pedagogical transmission within the *Gurukula* system, intended to train priests (*Adhvaryus* or *Hotṛs*) for formal rituals (*Karmakāṇḍa*). However, studying the texts academically is open to all. Historically, *Ṛṣikās* (female sages) such as Gārgī actively perceived and composed mantras and held highly respected positions within the Vedic tradition. Modern scholars, including Western academics like Stephanie Jamison, have produced comprehensive translations of the *Ṛgveda*. To advance this field, scholars from within the tradition must engage deeply in *Svādhyāya* (self-study) and rigorous translation, rather than waiting for external validation.

Societal origins were not an absolute barrier in antiquity; figures like Bālandana (a Vaiśya) and Kavaṣa Ailūṣa (who was not born a Brahmin but was esteemed for his vision of the Sarasvatī Sūktas) were recognized as great sages, demonstrating that intellectual merit was preserved and celebrated within the *Guru-Śiṣya* tradition.

Given the voluminous nature of Vedic literature—comprising over 150 primary texts and hundreds of ancillaries within the oral tradition—we must establish a principled approach. We begin by analyzing cosmological origins (*sṛṣṭi*), an approach pioneered by S.B. Dixit in the late 19th century. Dixit's groundbreaking comparative work on Vedic astronomy, originally written in Marathi, noted the total absence of such analytical works in traditional Sanskrit scholarship. Today, there remains a critical need for native scholarship to reclaim and advance the study of Vedic astronomy through rigorous textual analysis.

A prime example of early cosmological modeling is found in *Ṛgveda* 10.72. The text references an earlier epoch ("*pūrve yuge*"), indicating an early conceptualization of temporal periods or cycles. The hymn states, "*bhūr jajña uttānapadaḥ*" (the earth was born from the *uttānapada*). Sāyaṇa interprets *uttānapada* as trees (growing upwards), leading translators like Griffith to render it abstractly as "productive power." However, Dixit translates it more literally, linking it

to the subsequent Purāṇic figure Uttānapāda, the father of Dhruva (the Pole Star). If interpreted astronomically, this suggests a conceptual link to a fixed celestial pole.

The hymn continues: "Dakṣa was born of Aditi, and Aditi was born of Dakṣa." While traditional commentaries explain this through *devatā dharma* (divine mechanics), an astronomical perspective offers profound clarity. Aditi, often described as infinite (*Aditir Mātā*), is frequently interpreted by scholars like B.G. Tilak and S.B. Dixit as representing the ecliptic, the path from which the Ādityas emerge. Dakṣa, etymologically linked to *akṣa* (axis or pivot) and signifying precision, represents the celestial equator. The mutual birth of Aditi and Dakṣa beautifully conceptualizes the intersection and interdependence of the ecliptic and the celestial equator. The emergence of the directions (*āśā ajāyanta*) directly results from this celestial intersection.

Vedic cosmogony is not monolithic. Texts like the *Hiraṇyagarbha Sūkta*, the *Asya Vāmīya Sūkta*, the *Puruṣa Sūkta*, and the *Nāsadīya Sūkta* offer diverse theoretical models of creation. The *Śatapatha Brāhmaṇa* posits an initial state of *salila* (primordial waters) or, alternatively, asserts that only *manas* (consciousness) existed in a state that was neither being nor non-being (*sad-asad-vilakṣaṇa*). This diversity reflects a nascent, highly active intellectual civilization exploring varied theoretical frameworks, preserved immaculately through the oral tradition.

Fractions, Epicycles, and Planetary Theories

The development of quantitative measurement is a crucial marker of scientific advancement. In the *Ṛgveda* (e.g., 10.72), the conceptualization of numbers becomes prominent. The number 30 is particularly significant, recurring in phrases such as "Thirty leagues the wheel of the chariot is rolling" or "Thirty steps the bird has taken." In astronomical terms, this maps a continuous variable (time) onto discrete integers, representing the 30 *muhūrtas* of a day or the 30 days of a month.

The Vedic observers recognized the discrepancy between a mathematically idealized 30-day month and the actual synodic lunar cycle of approximately 29.5 days. *Ṛgveda* 10.55 explicitly addresses this required fractional correction, noting instances where a day (or *tithi*, in later terminology) must be dropped—referred to as an *ūna* (deficit) day or *vyaṅgam*. The verse describes an observer noting the moon over five nights and realizing the shifting sequence, demonstrating an advanced empirical understanding of the synodic month and the necessary fractional adjustments to reconcile observed phenomena with mathematical models.

Furthermore, the *Ṛgveda* contains numerical references that strongly correlate with planetary synodic cycles. While the specific term *graha* (planet) is absent, the numerical concepts are present. The number 4,320 days corresponds precisely to the roughly 12-year orbital cycle of Jupiter (Bṛhaspati) calculated in 360-day years. Similarly, numbers corresponding to the 378-day synodic cycle of Saturn are documented.

Finally, the conceptualization of the lunar nodes—the invisible intersection points of the solar and lunar paths required to calculate eclipses—is evident. While the terms *Rāhu* and *Ketu* are Purāṇic, the Vedic text refers to the eclipse-causing entity as *svarbhānu*. The recognition of an 18-year eclipse cycle necessitates an understanding of the mathematical retrograde motion of

these nodes. This demonstrates that Vedic astronomy involved rigorous observation, quantification, and the development of sophisticated mathematical models for planetary paths and invisible astronomical points.

(Q&A Session)

Audience Member: Thank you very much for this informative session. Could you shed more light on Sāyaṇa's *bhāṣya*? Why was it considered so comprehensive, and does it incorporate everything before him?

Professor Iyengar: Yes. Sāyaṇa's *bhāṣya* is akin to a reservoir into which all previous scholarly streams flow. He incorporates Yāska, Śaunaka, and whatever material was available to him. It is important to remember that he was supported by a team of 32 scholars. He did not write it alone; as a minister supported by the resources of the Vijayanagara empire, he facilitated the most massive documentation of Vedic meaning. While modern scholars may find faults or identify a ritualistic bias, his work remains indispensable. Without it, we would be left with only scattered fragments. He successfully preserved the linguistic and literal forms which we are now able to analyze for astronomical meaning.

Lecture of Prof. R. N. Iyengar (3)

The Vedic Perception of the Cosmos: *Pṛthvī* and *Dyauḥ*

The gist of what I said yesterday can be summarised in one line representing the Vedic perception: *Pṛthvī mātā, dyauḥ pitā* (Earth is our mother; the sky, or *Dyauḥ*, is our father). Note that "sky" here must not be taken merely in the English sense; *Dyauḥ* specifically represents the celestial father. These two exist together, and this combination has led to all subsequent theories, philosophies, and other concepts. You can set that poem aside to read later if you are unable to see it clearly now.

Today, we will see how this concept has developed further. Yesterday, I introduced some numbers—30, 15, 3, and others. I also provided a reference to the numbers in the *Ṛgveda* by V.S.N. Murthy; please try to understand it, as he systematically lists them. I mentioned the importance of numbers, their special characteristics, and their connection with the *Devas* (or *Devatās*). Astronomical data can be retrieved by viewing some of these *Devas*, at the very least, as representing celestial phenomena or concepts. When there are numbers associated with them, something astronomically significant should emerge. This is the fundamental, foundational theory for extracting astronomical information from the Vedic texts. This approach is highly important because, as we move to texts like the *Mahāsalila* and the *Parāśara Tantra*, these concepts are taken for granted. They become increasingly realistic and mathematical, whereas the early Vedic stage may appear idealistic or figurative; it is in a transitional stage rooted in the original principle of Dyauḥ pitā and *Pṛthvī mātā*.

For the Vedic people, the objects in the sky were not lifeless entities. They were all endowed with *caitanya* (consciousness). The Vedic seers did not differentiate strictly between trees, hills, stars, planets, the Sun, or *Vāyu* (the wind)—things you cannot even see but can only feel. The experiential reality, which we generally call *pratyakṣa* today (and which comes up in texts concerning *pramāṇa* or epistemology), is *indriya-janya* (born of the senses). But if you look carefully, while *indriya-janya* perception can be *pratyakṣa* (since *akṣa* implies the eye, implying that which is seen), *pramāṇa* (valid knowledge) can be of different kinds. For the Vedic people, astronomical phenomena may not have been exclusively visible with the eyes; they may have been perceivable in other ways, which I will elaborate on when we discuss the rituals.

The Astronomical Identity of Indra and Soma

In this talk, I will touch on Indra. As all of you know, Indra is widely considered the highest god in the *Ṛgveda*, a status held before the Purāṇic period introduced the triad of Brahmā, Viṣṇu, and Maheśvara. A ubiquitous characteristic of Indra is that he always drinks *Soma*. This leads to a particular issue: what exactly is *Soma-pāna*?

Today, Indra is popularly depicted—especially in dramas and films—as a king in his court, with apsaras (celestial nymphs) dancing, planets and ṛṣis sitting around him, and Indra shown drinking *Soma*. This is a highly peculiar, unfortunate, and frankly funny misrepresentation of how a civilization develops. I am not entirely against cultural entertainment, but there is a

profoundly deep, astronomical meaning here that has been lost. This loss has led to significant confusion, which persists to this day.

Soma, in all our languages, is universally understood as the Moon. We have names like Somanātha and Somaśekhara, which are taken in that sense and frequently connected with Śiva (Īśvara). It is a Purāṇic concept. However, the *Rudra* of the Vedas is different, and the *Viṣṇu* of the Vedas is different. We must be careful not to mix them up and create difficulties by assuming that the Purāṇic Viṣṇu or Śiva are exactly identical to their Vedic counterparts, because ultimately, everything represents *Brahman* (*sarvaṃ khalvidaṃ brahma*). For analytical approaches—and because we are studying *aparā vidyā* (lower/empirical knowledge) which is accessible to the senses and intellect—we must differentiate them.

When *Soma-pāna* is mentioned, people generally assume it refers to drinking. If you look at dictionaries or lexicons like the *Amarakośa*, that is the established meaning. However, consider what this implies: Western Indologists and modern texts often claim that *Soma* was a weed, an herb, or a fungus (like a mushroom) that the priests would crush to make a ritual drink, resulting in an intoxicated, heightened experience. This perspective is considered "scientific naturalism." But is this accurate?

Even in India today, when a *Soma-yāga* is performed, there is no original *Soma* plant available. They use a substitute, a *pratīka* (symbol/proxy). This concept of substitution (*pratīka*) is highly interesting but also troublesome, as you can substitute almost anything and claim it represents the original. This practice of substitution has significantly influenced Indian mathematics and algebra (*yāvat-tāvat*), but ritually, it implies that the original meaning might be lost. In many *Śrauta* rituals, there are long recitations (like the *Anuvākas*) just to compensate for the fact that they do not have the original elements.

The Numerical Code of the *Viśvedevāḥ*

Let us examine the *Purāṇas* and modern academic disciplines (like Indology promoted by Western scholars). *Soma* is described as a weed or a mushroom used for a ritual drink. I am not denying that rituals occurred, but the *Soma* they refer to in the sky is something entirely different.

There is an incredibly important number mentioned in the *Ṛgveda* regarding the *Viśvedevāḥ* (the All-Gods). The number is 3,339. This is explicitly stated in *Ṛgveda* 10.52.6:

trīṇi śatāni trī sahasrāṇi agniṃ triṃśacca devā navacāsaparyan > (Three thousand, three hundred and thirty-nine Devas offered worship to Agni).

What does this number indicate? It is the count of the *Viśvedevāḥ*. Who are they? The text states they are the *āyuḥ* (life/longevity) of Agni. Furthermore, there is a cosmic phenomenon being referenced here: the Moon's color turning red. A red-colored Moon generally indicates a lunar eclipse. In the context of this mantra, there is a specific Agni called *Śaucīkāgni*. The *Śaucīkāgni* is related to this number 3,339.

If we approach this mathematically, 3,339 is exactly 371 multiplied by 9. A solar year contains roughly 371 *tithis* (lunar days). If you multiply 371 by 9, you get 3,339 *tithis*, which corresponds to exactly 9 solar years. Nine years is precisely half of the 18-year Saros cycle (the eclipse cycle). Therefore, the 3,339 *Devas* represent the *tithis* leading up to an eclipse node! This is a highly foundational astronomical number, much more sophisticated than the simple base numbers, and it demonstrates that the Vedic seers possessed deep mathematical and astronomical knowledge regarding lunar eclipse cycles.

Yet, modern historical texts often dismiss this. They claim that the most ancient astronomy of the Babylonians relied on a fundamental 18-year cycle, supposedly discovered by the Chaldeans, and that the Indians simply borrowed it. They ignore the fact that the half-cycle (the 9-year, 3,339-*tithi* count) is explicitly documented in the *Ṛgveda* itself.

The *Sūryā-Vivāha Sūkta*: An Eclipse Allegory

Another profound example is the *Sūryā-vivāha Sūkta* (the marriage hymn of Sūryā). This describes the marriage of Sūryā (the daughter of the Sun) to Soma (the Moon). In this celestial marriage, the bridegroom is the Moon. A race is held among the gods to win her, and the *Aśvinau* (the twin horsemen) win the race.

The narrative states that Sūryā went to the head of *Mṛgaśīrṣa* (Orion). This entire narrative is an allegorical description of a celestial event, specifically an eclipse. The *Ṛgveda* (10.85.13) states:

aghāsu hanyante gāvaḥ arjunyoḥ paryuhyate

(The cows are slain in the *Maghā* [Aghā] nakṣatra, and she is carried away in the *Phalgunī* [Arjunī] nakṣatra).

When read literally, it sounds like an earthly wedding where cattle are slaughtered for a feast. However, astronomically, it describes the Moon (*Soma*) and the Sun (*Sūryā*) in conjunction or opposition near the lunar nodes during the *Nakṣatras* of *Maghā* and *Phalgunī*. The "slaying" of the rays (*gāvaḥ* means both cows and rays of light) represents the darkening of the eclipse. The red color of the eclipsed moon and the temporary loss of light are codified into the ritual language of a marriage procession.

Geometry and the *Yajñik* Altars

If we look at the ritualistic altars, we see the practical application of this knowledge. We have the *Gārhapatya* (a circular altar), the *Āhavanīya* (a square altar), and the *Dakṣiṇāgni* (a semicircular altar). Between these sits the *Darśa-Pūrṇamāsa Vedi* (the altar for the New and Full Moon sacrifices).

The spatial arrangement of these altars is deeply geometric. The *Vedi* is situated precisely between the fire altars. The exact geometric layout—transforming a circle into a square of the same area, orienting the semi-circle—was developed not just for building earthly fires, but to map the celestial mechanics onto the Earth. It is a direct physical representation of their astronomical metrics.

Prof. Iyengar's Lecture Note (4)

The Search for the Centre: *Bhuvana* and the Legend of *Dhruva*

Not so much is exact today, so slowly, as we come to the later periods, the nature of things changes and they become hopefully more easily understandable. In the previous texts, however, you need some reflection, some pondering, and perhaps you have to read more literature to fully grasp the concepts.

In the previous discussion, I showed you the positional framework of where *Svarga* (heaven) was supposed to be. The texts state: "*Ambasya pāre bhuvanasya madhye*" (Beyond the waters, in the center of the universe). The critical question then is: What was the center of the *Bhuvana*?

I am sure almost all of you know about *Dhruva* and the legend associated with him. This legend of *Dhruva*, as it stands, is quite well known. For those who might not be familiar, I will briefly summarize it. There was a king named Uttānapāda. The mention of this name is significant because yesterday we discussed the term "*Uttānapada*" from the *Ṛgveda*; there is a clear thematic connection here. King Uttānapāda had two wives: Sunīti and Suruci. Sunīti was the senior queen, while Suruci was the younger but dearer to the king.

Each queen had a son. The elder son (from Sunīti) was named Dhruva, whereas the younger son (from Suruci) was named Uttama—a detail that frequently appears in the Purāṇic accounts. When Dhruva went to the king's court and wanted to sit on his father's lap, Uttama was already sitting there. Dhruva also wanted to sit, but the younger queen, Suruci, obstructed him, telling him not to sit on his father's lap along with her son due to jealousy.

Upset, Dhruva went to his mother, Sunīti. Being mature, wise, and knowledgeable, she told him, "Why are you worrying over a position on your father's lap? You can achieve a much better position than that." When he asked how, she advised him to go and perform *Tapas* (penance) for Lord Viṣṇu. On his way, he met the sage Nārada, who imparted the *Aṣṭākṣarī mantra* (the eight-syllabled mantra) to him. Dhruva went and prayed, and finally, Viṣṇu manifested before him.

When Viṣṇu asked what boon he desired, the young boy was overwhelmed and could not open his mouth to speak. Viṣṇu then touched the boy's cheek with his *Śaṅkha* (conch), granting him *Divyajñāna* (divine knowledge). Viṣṇu declared, "You will get the best position in the world. You will attain the center of the *Bhuvana*. You will become the Pole Star, and you will remain as the Pole Star until the end of the world." This is, at least, what the *Purāṇas* state.

There is an interesting dynamic between the *Brahmāṇḍa Purāṇa* and the *Viṣṇu Purāṇa*. The *Brahmāṇḍa Purāṇa* does not detail the story of the two queens quarreling; that narrative appears more prominently in the *Viṣṇu Purāṇa* and later texts, which feature a three-hour expanded story typical of evening temple discourses, complete with beautiful drawings and paintings of Dhruva. But fundamentally, we must understand the astronomical core: What is that center of the Earth where he stood?

The *Viṣṇu Purāṇa* adds a slight variation, stating that not only Dhruva, but his mother will also be with him throughout time as a celestial body—represented by a star or a moon—remaining with him continuously.

The Astronomical Reality of the Pole Star

Now, let us examine the astronomical reality of this story. Today, if you ask where Dhruva is, and you take your children to a planetarium, Dhruva is indeed there—it is the Pole Star (Polaris). But today's Pole Star is *not* the Pole Star that Dhruva became in that ancient period.

This is a highly peculiar issue. How did this happen? How do we know this? What is the evidence? Why do we know that what the *Purāṇas* say is not referring to today's Dhruva? The *Purāṇas*, as they are generally accepted, were written down and compiled somewhere during the Gupta period (roughly 4th to 6th centuries CE). Now, during the Gupta period, was there a Pole Star to inspire this story?

Modern astronomy dictates that there was *no* exact Pole Star from approximately 1500 BCE until 1500 CE. For nearly 3,000 years, there was no prominent star exactly at the celestial pole. How, then, do you explain a Pole Star? How did the *Purāṇas* describe it, and does it have a previous connection to the Vedas? If, according to modern astronomy, there was no Pole Star when these texts were formalized, what is this story truly about? This is a key issue for chronology and cultural history.

Some politicians and commentators make claims about the *Mahābhārata* and ancient anchor dates that are not scientifically rigorous. If we want a reliable anchor, it must be accepted by many and provable through modern astronomical theories—because we are moderns looking at the past through an analytical lens.

The *Śiśumāra* Constellation (Draco)

What exactly is the text describing? In our daily *Sandhyāvandana* (evening prayers) and other rituals, there are specific mantras. For instance:

Bhūḥ prapadye, bhuvaḥ prapadye... These are empowerment mantras utilized by practitioners.

Furthermore, the texts describe a divine, powerful celestial creature: the *Divya Śākvara Śiśumāra*. This constellation looks like a serpent or a dragon. In the *Purāṇas* (both *Brahmāṇḍa* and *Viṣṇu Purāṇa*), this constellation is called *Śiśumāra*. It is said:

Śiśumāra śiraḥ pucche dhruvas tiṣṭhati...

(Dhruva is situated at the tail of the Śiśumāra).

The text enumerates 14 specific stars within this constellation. At the various points of this creature (the jaw, the head, etc.), reside deities like Agni, Indra, Prajāpati, and Abhaya. This celestial animal is described as a powerful aquatic creature. The texts use the term *Timiṅgila* (a giant whale or sea monster that swallows other fish). The analogy is clear: just as a massive fish swallows smaller fish, this massive constellation dominates that part of the sky.

This constellation corresponds to what modern astronomy calls Draco (the Dragon). At the very tail of this constellation lies the 14th star—this is the ancient Dhruva. We know this star today as Thuban (Alpha Draconis). Due to the precession of the equinoxes, Thuban was the exact Pole Star around 2800 to 3000 BCE.

This implies that the *Purāṇic* memory of Dhruva being placed at the center of the heavens points directly to an astronomical reality from 3000 BCE. During the time the *Purāṇas* were later compiled, there was no Pole Star, but they meticulously preserved the precise constellation mapping from millennia earlier! This proves a continuous, unbroken transmission of observational astronomical data.

Vedic Geometry and the *Vedī* (Fire Altar)

Is there evidence of this in the older Vedic texts? Yes, absolutely. It is heavily documented in the *Taittirīya Āraṇyaka*, particularly in the *Kṛṣṇa Yajurveda*.

The texts detail a ritual where the *Yajamāna* (the patron of the sacrifice) and the *Yajamānapatnī* (his wife) must align themselves with the cosmos. It explicitly mentions turning to the North to observe this celestial arrangement. Why the North? Because that is where the fixed center of the rotating sky (the Pole) is located.

This alignment is practically applied in the construction of the *Vedī* (the fire altar). The *Śulba Sūtras* provide the precise geometry for this. The layout features the *Gārhapatya* (circular), the *Āhavanīya* (square), and the *Dakṣiṇāgni* (semi-circular) fire pits. Between them lies the main *Vedī* for the *Darśapūrṇamāsa Yāga* (New and Full Moon sacrifices).

The geometry is highly specific. The *Vedī* is 96 *Aṅgulas* long. The eastern side is 48 *Aṅgulas* wide. It forms a specific trapeze shape. To construct this, the priests used a *Rajju* (rope) and *Kīla* (pegs) to draw arcs, bisect lines, and square circles. This is practical geometry directly tied to astronomical alignment. The *Vedī* itself is anthropomorphized; it is shaped like a *Yoṣā* (a woman), specifically representing the Earth goddess connecting with the celestial deities.

The Precession of the Equinoxes and Eclipse Cycles

The ancients were acutely aware that the sky shifts over vast periods. The shifting of the Pole Star from Thuban (Alpha Draconis) toward our modern Polaris is caused by axial precession. The Earth's axis wobbles like a spinning top, completing one full circle every 25,000 to 26,000 years. The ancient texts encode this slow rotation.

Furthermore, they utilized these fixed alignments to predict eclipses. They recognized the 18-year Saros cycle. If a lunar eclipse happens in a specific *Nakṣatra* today, a nearly identical eclipse will happen in that same *Nakṣatra* roughly 18 years (and 10 or 11 days) later. This cycle was mapped meticulously.

To conclude this section, the narrative of Dhruva is not merely a moral fable about a devoted child; it is a mathematically and astronomically precise memory of the celestial pole from 3000 BCE, preserved through complex geometry, ritual altars, and continuous oral transmission across thousands of years.

The Evolution of the Ancient Cosmos: Tracing *Dhruva* and the *Śiśumāra* Constellation

Not so much esoterically. So slowly, as we come to the later periods, the nature of things changed. They become, hopefully, more easily understandable. Whereas in the previous ones, you needed some reflection, some pondering, and maybe you had to read more literature to fully grasp the concepts.

In the previous discussion, I showed you the positional framework of where *Svarga* (heaven) was supposed to be: "*Ambasya pāre bhuvanasya madhye*" (Beyond the waters, in the center of the universe). So regarding *bhuvanasya madhye*, what exactly was the center of the *bhuvana*? That is the critical question.

Now, I am sure almost all of you know about Dhruva and the legend associated with him. This legend of Dhruva, as it stands, is quite well known. Is there anyone who doesn't know the legend of Dhruva? Raise your hand. Who doesn't know the story of Dhruva from the *Purāṇas*? Oh... okay. It is very simple.

There was a king named Uttānapāda. I mention that name because yesterday we already encountered the term *Uttānapada* (in the *Ṛgveda*); there is a clear connection here. King Uttānapāda had two wives: Sunīti and Suruci. Sunīti was the senior queen, while Suruci was the younger, but dearer to the king. That was the situation. Each had a son. The elder son (from Sunīti) was named Dhruva, whereas the second son (from Suruci) was named Uttama. This is the narrative as it appears in the *Purāṇas*.

When Dhruva went to the king's court and wanted to sit on his father's lap, Uttama was already sitting there. Dhruva also wanted to sit. But the younger queen, Suruci, obstructed him.

The Astronomical Shift: The Changing Pole Star

[The speaker transitions from the narrative of Dhruva to its astronomical implications, discussing how the position of the Pole Star is not static.]

So slowly, we come to the later periods, and the nature of things changed. They become hopefully more easily understandable.

What has been shown here is the Earth, and this is the North Axis which is pointing upwards. This is the ecliptic. If you look at only the North—the top part—yesterday, M.D. Srinivas was mentioning the polar circle. This is the polar circle. This is how the rotation of the Earth's axis is taking place.

The Earth has three kinds of motion:

1. The diurnal rotation about its own axis.
2. The revolution about the Sun, which takes roughly one year.
3. The precession.

This precession cycle is like a top; slowly, it is moving in a circle. For a person who is looking to the North, they will think whatever star is at that central point is the Pole Star, because it will

remain fixed. The other stars are rotating, but this point will appear fixed. However, because it is moving very slowly—this entire cycle takes 26,000 years—it remains seemingly fixed for a very long time. This is called the precession. It moves roughly one degree for about 72 years, which you can mathematically calculate.

The same phenomenon happens here. This is the Dhruva today, in 2000 AD. This is the fixed Pole Star. Whereas, sometime back—which was shown here—there was another Dhruva. That circle is what has been plotted here. So the star on this polar circle can temporarily be a Pole Star.

What is the meaning of that? I will come to another figure to explain. The one which was a Pole Star previously—that means the most recent one before ours, located here around 3000 BC—in modern astronomy is called Thuban, or Alpha Draconis. That constellation is this constellation, which looks like a serpent or a dragon. This is what is called the *Śiśumāra* in the *Purāṇas*—the *Brahmāṇḍa Purāṇa* and the *Viṣṇu Purāṇa* included.

"*Śiśumārasya pucche dhruvas tiṣṭhati*" is what the text says. This *Śiśumāra* has fourteen stars, and you can identify them. The 14th star is the Dhruva—the last star located at the tail. If you think of this as an animal, this is the face, this is the tail, and this is here. This was possible only around 3000 BC. Take this as a hypothesis for the time being: the *Purāṇas* talk about this, but when the *Purāṇas* were written in 500 AD, there was nothing at this polar point. Yet, they still recorded it! How did that happen?

There was previous knowledge. The 3,339 gods in the *Purāṇas* carried over some past knowledge. The *Brahmāṇḍa Purāṇa*, by its very name, indicates it has to explain the cosmos (*Brahmāṇḍa*). How did it explain that? It explained it all with reference to Dhruva. That is what is called the Meru-centric astronomical model—that Dhruva is holding the universe, and all others are going around it. It is a circular model.

Textual Evidence of the Ancient Pole Star

This is not the Greek model, where the Greeks think there is a glass ceiling so that the stars don't go above it or whatever. Here it is not like that; it is infinite. But Dhruva is holding it. So around Dhruva, all this is moving. There is something that connects them—you have to imagine a *Meru parvata* (Mount Meru) or a Meru axis, simply called Meru sometimes, or simply *Meḍhī*, or *Methī* sometimes.

That description is here as an oil mill model, or a potter's wheel model. Just as a potter rotates the wheel to create pots, things are rotating, but it can also be fixed. The center is fixed, but the outer rim is rotating. The *Nakṣatra cakra* (star wheel) and other things may be rotating. We have no objection; the Sun, Moon, and stars may all be rotating, but there is something fixed. That *bhuvanasya nābhiḥ* which came from the beginning—*nābhi* always generally means center, the navel. There is so much importance attached to that. Later on, it became called Dhruva because it is fixed. But Dhruva also started moving! That is the sad story, and that transitions into later cultural issues.

Now, what is the evidence for this? Is there anything older than the *Purāṇic* statement available? It is there in the *Taittirīya Āraṇyaka*. The *Taittirīya Āraṇyaka* belongs to the *Kṛṣṇa Yajurveda*. In the *Kṛṣṇa Yajurveda*, there is a very important mantra which is repeated in South India very commonly in almost all temples. Because the *Taittirīyas* migrated from the North and came to the South for whatever reason, we will not go into that.

But there are issues with the tradition of the *Taittirīyas*. They themselves say that part of this is from the *Kaṭha Śākhā*, so they adopted it into their own *Śākhā*—the *Prapāṭakas* and all that. So it definitely came from some past era and other branches of the *Yajurveda*, when they were all together in Kurukṣetra or wherever during that imagined period.

This mantra asks us to worship this cosmic entity, doing *dhyāna* (meditation) because of *Bhūḥ prapadye, bhuvaḥ prapadye...* So there is a cosmic worship that happens, which has continued in the Vedic tradition to this day as *Sandhyāvandana* in the evening. In the evening, people are told to turn to the North and do the *Upasthāna*. Why the North? Because in the morning it is the East, when the Sun sets it is the West, so the *Arghya* is given there. Why the *Upasthāna* in the North? Sāyaṇa explains in his *Bhāṣya* in the 14th century:

"*Dhruva maṇḍalaṃ paśyan upatiṣṭhet...*" (One should stand looking at the circle of Dhruva).

The culture has continued, even though the stories have been forgotten, and this is astronomical. I have put this up because I wrote this for a publication, so I have to read it slowly.

The Ritual and the Constellation

The declaration is plotted here for Thuban as well as Sunīti. Sunīti is the mother, and the modern name is given in your notes. Both of them—the texts state they don't set, they go near 90 degrees at the time of 2800 BC. The other three stars also, for the sake of comparison, I have put up, because the *Purāṇas* say the four stars do not set nor rise. These last four stars are circumpolar. You get some information out of this. The circumpolar stars don't have any rise or set; they are visible all through the year, strictly speaking. We are talking about the Northern Hemisphere. In South India, it may be difficult to see some of them because you are coming lower in latitude, but for the *Purāṇas*, the last four were not setting.

So you can combine these things and know the rough era where it might have happened, or when it lasted for a particular place—the circumpolarity. You can locate that point up to about 25 degrees North, up to about 2000 BC it was not setting. After that, these *Purāṇic* concepts might have evolved, where orally transmitted knowledge and other things were mixed up.

This is clearly stating:

"*Paryeṇteśye meḍhī bhūtaṃ dhruvaṃ divi. Agnīndra kaśyapānānto caramo'smin dhruva smṛtaḥ.*"

This is again a *Brahmāṇḍa Purāṇa* statement. The *Viṣṇu Purāṇa* gives similar things, and it is very strong here compared to the *Viṣṇu Purāṇa*. That is why I am quoting this. It is very near to the Vedic period. "*Eka eva bhramatyeva meru parvata mūrdhani*"—he says it rotates over

the Meru mountain. So the *Purāṇas* had also observed some rotation: "Yes, Dhruva is fixed, but also he is rotating there!" That means, after roughly 2850 BCE, about a thousand years later, you would see that, in the night, it will rotate a bit. It is very important because Āryabhaṭa particularly knew the diurnal rotation of the Earth. Where did he get it? The *Purāṇas* say that Dhruva rotates a bit around the pole. So Āryabhaṭa might have taken this concept and made it a relative model. Instead of the heavens rotating, the Earth itself rotates! We don't know, because the other astronomers didn't accept it.

The Ritual Calendar, Eclipse Cycles, and the *Dākṣāyaṇa Satra*

For cultural astronomy, or for teaching in a liberal arts department, this material is available on the web; you can see it for yourself. Unfortunately, we are not integrating such things into our educational systems. But anyway, let me go further.

This is also reflected in the calendar. You may remember the mantra which states that Prajāpati's joints became weak, and only through the *Darśapūrṇamāsa* (the New and Full Moon sacrifices) could he be set right, whereupon his joints became strong again. This is fundamentally a time measure. It means that the *Amāvāsyā* (New Moon) and the *Pūrṇimā* (Full Moon) had to be precisely fixed. The exact length, the specific numbers, and the precise timing all had to be established.

While the *Mahāsalila* text has something to say on this—and it is more developed there—in the earlier periods, it was still evolving. Here, I must mention R. Shamasastry, a very famous and extraordinarily great Indologist from Mysore, who was the first to discover and edit the *Arthaśāstra* of Kauṭilya. He also authored several other books, one of which is titled *The Vedic Cycle of Eclipses*, published in 1938.

I do not accept everything he postulated in that work, and it is available online in the archives for you to download and evaluate. However, it is a wonderful book. He presents an immense amount of information and diverse, complex modes of thinking. One of the points he highlights is how the Vedic rituals were utilized as an astronomical calendar. This concept is already embedded in the Vedas.

The *Darśapūrṇamāsa yāga* is mandated to be performed either for 15 years, for 30 years, or optimally, lifelong. There are *Agnihotrins* who perform this lifelong even today, because once the *Darśapūrṇamāsa* is initiated, it is traditionally supposed to be maintained. (For instance, at a recent meeting, there was an *Agnihotrin* from Varanasi who explained his desire to complete a deferred *Darśapūrṇamāsa* cycle; such practitioners maintain these exact traditional timings so that the rituals do not erroneously overlap with *Pūrṇimā* or *Amāvāsyā*). These practices continue, but they are rooted in the astronomical parameters established in those ancient days.

If you consider these 15 and 30-year periods, what happens mathematically? If you perform the *Darśapūrṇamāsa* for 30 years, the two calendars—lunar and solar—synchronize. There is a specific mantra and vow called the *Dākṣāyaṇa Satra* (or *Dākṣāyaṇa Vrata*). The instruction is to perform this sacrifice for 15 years. In 15 years, there are exactly 360 Full Moons and New

Moons. (If you multiply 15 years by 24 half-months, you get exactly 360). There are 360 nights in their idealized year. Thus, he gains these nights in 15 years.

If he performs this *yāga* for another 15 years, he "gains the year itself." What does this mean? It means the two cycles coincide! The lunar and solar cycles converge very closely at this specific interval. A purely lunar year consists of roughly 354 days (or 360 *tithis*), whereas a solar year consists of approximately 371 *tithis*. The difference is 12 *tithis* (or roughly 11 days).

If you perform the *yāga* for 30 years, 12 days added each year over 30 years equals 360 days. Thus, one full extra lunar year is added to the *tithis*! The lunar and solar cycles seamlessly intercalate. This is an incredibly important astronomical synchronisation. In the Vedas, you see some people functioning as *Ṛtu yājis* (sacrificing according to the seasons) and others as *Darśapūrṇamāsa yājis*. They actively tried to synchronise the solar and lunar calendars through these precise, extended ritual periods.

Long-term observation was absolutely necessary. Furthermore, 30 solar years (nearly 29 years) correspond to another vital eclipse cycle known as the *Inex* cycle. The 18-year cycle is the *Saros* cycle, but the 29-year cycle is the *Inex* cycle. Modern astronomers know that *all* eclipses can be predicted using a linear integer combination of the Inex and Saros cycles. The formula is $aI + bS$ (where I is the Inex and S is the Saros). This mathematics is available in standard textbooks.

The ancient Indians were very close to this realisation, which is why they *had* to observe eclipses. Otherwise, this level of synchronisation is impossible. If you look at the node (what we later call Rāhu), its cycle is 18.6 years. In later astrology, different periods are assigned to different *Grahas*, but for Rāhu, it remains 18 years even today! This concept of the 18-year cycle is deeply embedded. If you read Burgess's translation of the *Sūrya Siddhānta*, he explicitly notes how ancient Indians knew these planetary periods. The number for Rāhu reduces to exactly 18.6 years (which perfectly aligns with the nodal regression cycle). He notes that some Hindus must have had this precise number available to them, while others argue it was derived from Babylonian sources.

This *Pañca-saṃvatsara* (five-year) calendar is not just a later invention; it is already present in the *Taittirīya Brāhmaṇa* and the *Kāṭhaka Brāhmaṇa*, and it is heavily elaborated upon in the *Mahāsalila*.

Textual Corruptions and the 33 Deities

This leads to a critical problem for those of us engaging with the *Purāṇas*. We have no critical editions for many of the *Purāṇas*. While some claim there is a critical edition of the *Viṣṇu Purāṇa*, they often do not scrutinize the astronomical numbers. They simply list the verses from Northern or Southern recensions.

For example, the *Viṣṇu Purāṇa* lists the number of deities as:

Trayastriṃśat sahasrāṇi trayastriṃśat śatāni ca...

(Thirty-three thousand, and thirty-three hundred...)

The *Liṅga Purāṇa* provides the exact same verse. Many translators render this as 36,333 deities (33,000 + 3,300 + 33). But astronomically, this is a corruption! The original Vedic root for this number should not be *trayastriṃśat* (thirty-three) but *trī śata* (three hundred). The original Ṛgvedic number for the eclipse cycle *tithis* is 3,339 (*trīṇi śatāni trī sahasrāṇi...*). Because the scribes saw "33" at the beginning, they erroneously standardized the entire sequence to 33,000 and 3,300. This is exactly why a critical edition with *domain knowledge*—astronomical knowledge—must be produced in this country. I doubt it will happen in my lifetime, but future scholars must undertake this.

The Geometry of the Altars: The *Baudhāyana* Theorem

Let us quickly look at the *Baudhāyana* theorem (often referred to as the Pythagorean theorem). You can see the extensive literature available on how this is mentioned in the *Śulbasūtras*. The foundational statement is:

Dīrghacaturaśrasya akṣṇayā rajjuḥ pārśvamānī tiryaṅmānī ca yat pṛthagbhūte kurutastadubhayaṃ karoti.

(The diagonal cord of a rectangle produces both areas which the perpendicular and horizontal sides produce separately.)

These geometric properties were observed in rectangles (3-4-5, 12-5-13, 15-8-17, 7-24-25 triangles, etc.) and utilized for constructing precise ritual altars. A classic mathematical operation found in the *Śulbasūtras* is squaring the circle (or circling the square). If you take a square with an area, these geometric properties were observed in rectangles (3-4-5, 12-5-13, 15-8-17, 7-24-25 triangles, etc.) and utilised for constructing precise ritual altars. A classic mathematical operation found in the Śulbasūtras is squaring the circle (or circling the square). If you take a square with an area of $4a^2$, and you must draw a circle of the exact same area, the Śulbasūtras instruct you to construct the radius as:

$r = (a/3)(2 + \sqrt{2})$

From this, you can easily derive their working value of Pi (π). Using their approximation for $\sqrt{2}$, the value of π calculates to approximately 3.088.

This means the area of the circle is not *exactly* equal to the square, but the error is a mere 1.7%. They even provided further corrections to refine this!

The Cosmic Altar and the Celestial *Dhruva*

All of this geometry was fundamentally connected with the *Dārśikī Vedī* (the altar for the New Moon sacrifice). The construction of the *Vedī* was tied directly to celestial observations. The *Baudhāyana* and *Āpastamba* texts describe this rigorously. The ritual is not mere entertainment; it is a highly accurate, choreographed representation of cosmic mechanics.

During the sacrifice, the priests perform specific actions with absolute precision. While to an uninitiated observer it might look like a mere drama—a priest holding a wooden sword (*sphya*), shouting *Vaṣaṭkāra*—every action is symbolically and astronomically calculated.

For instance, when consecrating the boundaries of the altar, the priest addresses the Northern boundary with this specific mantra:

Mitrāvaruṇau tvottarataḥ paridhattāṃ dhruveṇa dharmaṇā.

(May Mitra and Varuṇa secure you in the North with the firm/fixed law).

Why the North? Because that is the domain of *Dhruva*—the fixed Pole Star! The concept is that the altar must be anchored to the unmoving center of the heavens. The *Yajamāna* (the patron) then prays:

Pranayā yajñaṃ devatā vardhaya... tvannākasya pṛṣṭhe yajamāno'stu... saptarṣīṇāṃ sukṛtāṃ yatra lokaḥ.

(Lead the sacrifice forward, increase the deities... may the Yajamāna be on the vault of heaven... where the realm of the Seven Sages [Ursa Major] and the righteous lies.)

The participants are conceptually transported to the sky. Where do they wish to go? To the *Nākasya pṛṣṭhe* (the vault of heaven), situated *Ambasya pāre* (beyond the celestial waters). What are these "waters"? It is the Milky Way. If you look at the night sky, the Milky Way flows like a river, and near it lies the Draco constellation, housing the ancient *Dhruva*. The entire earthly ritual is a geometric and spiritual map of the polar sky.

The Anguish Over Ignored Astronomical Meanings

This brings me to expressing my deep anguish over how we have neglected our own intellectual heritage. I cannot be more angry at myself, my fellow countrymen, and the great scholars of this country who are unable, or unwilling, to interpret the Vedic mantras properly with domain knowledge.

Consider these famous verses from the *Taittirīya Brāhmaṇa* and the *Ṛgveda* (often overlapping with the *Sūryā-vivāha Sūkta*). People look at them and say, "Is this about the Sun and Moon? Is it about eclipses? Do they really know all this?" Any curious student will ask these questions.

Dve virūpe carataḥ svarthe anyānyāṃ...

(Two beings of different forms move along their own paths, one after the other...)

Pūrvāparaṃ carato māyayaitau śiśū krīḍantau pariyāto adhvaram.

(Moving East and West by their mystic power, these two playing children circle the sacrifice.)

Viśvānyanyo bhuvanābhicaṣṭa ṛtūnranyo vidadhajjāyate punaḥ.

(One [the Sun] observes all the worlds; the other [the Moon] orders the seasons and is born again and again.)

Navo navo bhavati jāyamānaḥ...

(He becomes new again and again as he is born...)

If you read standard commentaries, like Sāyaṇa's *Bhāṣya*, they simply state that this refers to day and night (*virūpe carate*), or the Sun and the Moon. That is true, as far as it goes. But what about the specific numbers attached to them?

Some scholars dismiss the numbers, claiming that "33 deities are sufficient, and any larger number is unnecessary hyperbole." This is exactly what is written in many modern commentaries! I am sure the same person did not write the *Ṛgveda* and the *Taittirīya Brāhmaṇa* commentaries, but the dismissive attitude remains the same.

Why is this my anguish? Because these verses from the *Ṛgveda* are explicit. The numbers are not arbitrary; they are astronomical constants. The "3,339 Devas" exactly match the *tithi* count for a 9-year half-eclipse cycle. The *Sūryā-vivāha Sūkta* describes the exact *Nakṣatras* (*Maghā* and *Arjunī/Phalgunī*) where the eclipse nodes were located during that epoch. It explicitly details the Sun and Moon "playing" and intersecting their paths (*māyayaitau*), constrained by these highly specific numbers.

When you read these mantras, they clearly describe the mechanics of the Sun and Moon going round and round, constrained by exact mathematical cycles, leading to eclipses. To dismiss this as mere poetry about "day and night" or "playing children," while ignoring the precise mathematical data (like the 3339 *tithis*), is an academic tragedy. It requires researchers with deep astronomical knowledge to decode them, rather than relying solely on superficial linguistic or ritualistic translations.

We must stop taking these texts amiss and recognize the profound scientific and astronomical rigor embedded within our ancient heritage.

The Second Half of the Lecture (4)

The Continuity of the *Dhruva* and *Śiśumāra* Concepts

Let us continue with our discussion on *Dhruva* and the *Śiśumāra* (the celestial dolphin or Draco constellation). The fundamental questions that arise are: How did this tradition continue? What are the pieces of evidence, and how was it historically believed? How did the present-day *Dhruva* concept emerge? Even today, the ritual of *Dhruvadarśana* (viewing the Pole Star) occurs because it is a fixed ritual. However, we must ask: Which *Dhruva* should be seen? Are we observing the wrong celestial body? Should we be looking at the current Pole Star or a completely different one? These questions are of great historical and astronomical importance, and I will briefly touch upon them.

When we examine the first millennium CE, specifically the 8th century, we find corroborating references. I am quoting here from the *Viṣṇu Sahasranāma Bhāṣya* of Śaṅkarācārya. The *Viṣṇu Sahasranāma* is a highly popular text. In it, the name *Nakṣatranemi* appears (Name 141), which is a synonym for Lord Viṣṇu.

How does Śaṅkarācārya explain this name? He states very clearly:

"*Śiśumārasya hṛdaye jyotiḥ... sthito viṣṇuriti nakṣatranemiḥ.*"

He explains that Viṣṇu is situated as the light at the heart of the *Śiśumāra*. Furthermore, Śaṅkarācārya directly traces this concept back to the Vedic corpus, stating:

"*Śiśumāra varṣmaṇe viṣṇuṃ hṛdayam... Taittirīya Āraṇyakam.*"

This represents the actual commentary available today, which you can easily download and read. Thus, the concept of Viṣṇu and the astronomical phenomena that Śaṅkarācārya discusses are intrinsically linked to the *Śiśumāra*. He clearly uses the word *Śiśumāra*—though later on, some texts refer to it as *Śiṃśumāra*, which is a very minor phonetic variation and means the exact same thing.

This reference proves that even in the 8th century CE, when there was no actual Pole Star stationed exactly at the celestial pole, the memory and conceptual framework of the *Śiśumāra* remained intact. Similarly, astronomers like Brahmagupta had already discussed the *Dhruvamatsya* (the Ursa Minor constellation). As a result, the astronomical traditions bifurcated. The regular, mathematical astronomy adapted to a realistic view of the sky, focusing on mathematics and actual coordinates. Meanwhile, the *Vaidikas* and the cultural traditions retained the older, historical references, preserving the textual narratives and the Purāṇic models from the past.

Iconography and Cross-Tradition Acceptance

We are not an isolated set of Hindus. We have different *sampradāyas* (traditions), but the underlying *paramparā* (lineage) remains the same. This *paramparā* is validated when we collect the textual evidence and compare it.

To illustrate this, the *Mādhva sampradāya* has brought in a specific iconography of this concept. Such an idol is located right here in Bangalore. While I have not seen it in person yet, I managed to acquire a photograph of it. The icon depicts Viṣṇu as the *Śiśumāra*—"*Śiśumārarūpī Viṣṇuḥ*."

If you observe the iconography, it is not a standard fish. It has four legs and is clearly meant to represent Viṣṇu in the form of this celestial creature, with *Dhruva* situated at the tip of its tail. This icon is worshipped alongside the *Śālagrāmas*, indicating that it serves as an equivalent representation of Viṣṇu. Some conceptualizations suggest that *Dhruva* himself embodies Viṣṇu, or that *Dhruva* represents Acyuta. This concept is also prominent in the *Bhāgavata Purāṇa* and several North Indian poetic traditions.

Al-Biruni's Observations on Indian Astronomy and the *Yogasūtras*

There is further external evidence provided by Al-Biruni. When Al-Biruni arrived in India in the 11th century, he maintained a profound interest in Indian science. He studied Brahmagupta, Varāhamihira, the *Purāṇas*, and the *Yogasūtras*. He even translated the *Yogasūtras* into Arabic/Persian.

His writings reveal a deep engagement with Indian texts. In his work, he specifically references *Dhruva* in the context of the *Yogasūtras*. There is a famous *sūtra* (3.28) regarding *Dhruva*:

"*Dhruve tadgati jñānam.*"

This translates to: "By performing *saṃyama* (meditation/concentration) on the Pole Star, knowledge of the motion of the stars is obtained." But what does this mean according to the classical commentaries? They state that it refers to the motion of the Moon and the *Nakṣatras*.

However, Al-Biruni notes an anomaly. He points out that the rule of *samāsa* (compound resolution) in Sanskrit dictates that the relationship should be applied to the nearest grammatical referent. Therefore, the *gati* (motion) should strictly refer to the motion of *Dhruva* itself! Even based on traditional interpretations, the grammatical structure points to the motion of *Dhruva*. This is a highly astute observation by an external scholar, and he learned this directly from his Indian gurus and teachers.

He notes that observing the Pole Star allows one to understand its own subtle motion. He then quotes the *Purāṇas* and shares an interesting critique. He says:

"The Hindus tell rather ludicrous tales when speaking of the figure in which they represent the group of stars... namely, the figure of a four-footed aquatic animal, which they call *Śākvara* and also *Śiśumāra*. I suppose that this animal is the great lizard... which in Persia is called *Susmār*, which sounds much like the Indian *Śiśumāra*."

Al-Biruni is sarcastic here, but it forms a historically vital record. He questions why the Hindus conceptualize this constellation as a four-footed aquatic animal rather than a fish. His critique, however, serves as robust evidence for us today. It confirms that the Pole Star conceptualized as a four-footed aquatic creature (*Śiśumāra*) was a firm, established belief passed down from the Vedas to the 11th century. The word *Śākvara* is explicitly a Vedic term, not commonly used in classical Sanskrit. Al-Biruni would not have known that term had his 11th-century teachers not directly taught it to him based on ancient texts.

Ritual Application: *Dhruvadarśana* in Marriage and Kālidāsa's *Kumārasambhava*

This memory of *Dhruva* continues directly into our cultural practices, specifically the *Dhruvadarśana* ritual during the Hindu marriage ceremony. As you know, the bridegroom is required to point out the Pole Star to the bride.

The great poet Kālidāsa immortalized this in his epic *Kumārasambhava*, describing the divine marriage of Śiva and Pārvatī. He writes (7.85):

"*Dhruveṇa bhartrā dhruvadarśanāya prayujyamānā priyadarśanena |*

Sā dṛṣṭa ityānanamunnamayya trīkṣaṇakaṇṭhī kathamapyuvāca ||"

In this beautiful verse, Śiva (the eternal husband) directs Pārvatī to look at *Dhruva*. Pārvatī, who is shy, tilts her face upward and softly whispers, "*Dṛṣṭa*" ("I have seen it").

This establishes that the *Dhruvadarśana* was an integral, permanent fixture of the cultural consciousness. We will skip a few subsequent textual details, but the core astronomical memory remains unshakeable.

Meru-Centric Cosmology and Conclusion

This brings us to the concept of Meru-centric astronomy, which originated precisely from these ancient observations. There are numerous modern articles, mostly by Western scholars, discussing the Meru-centric cosmology found in the *Purāṇas* and the Vedas, and how they mapped their cosmography.

Recently, groups like ISKCON have taken a strong interest in the cosmography presented in the *Bhāgavata Purāṇa*. Jaina texts also possess their own detailed Meru-centric cosmology. While Jaina texts do not explicitly refer to *Dhruva*, the concept of Mount Meru as the cosmic axis remains central. Thus, an imaginary, theoretical *Meru* has endured to this day, even as the visible celestial configurations shifted and vanished due to precession.

These are the enduring astronomical ideas that survive in our texts, whereas the immediate physical realities shifted. We must keep this in mind. This ancient cosmography is incredibly important for fully understanding the history of our astronomy.

Thank you so much. We can now take any questions.

Q&A Session

Host: Are there any questions?

Student: Sir, do you have any paper on this topic of the *Śiśumāra* and its transition?

Prof. Iyengar: Are you asking if I have a paper on *Dhruva*? Yes, I have given it to you.

Student: Oh, okay. Is that the long paper that was provided?

Prof. Iyengar: Yes, it is included in your notes. You will have to take the trouble to read it! It is the longest paper because I wrote it systematically. Since it was already prepared, I just attached it. It is also available in a shorter version in the *Journal of Astronomical History and Heritage* (2011), which you can download and read. The preliminary concepts are there, though I have added more recent findings to the longer notes provided to you.

Student: Sir, with respect to the astronomy before the Common Era, is there any mention of the other *Dvīpas* (geographical continents/islands)? Apart from *Jambūdvīpa*, are the other *Dvīpas* mentioned?

Prof. Iyengar: That is a question concerning *Pṛthvī* (the Earth/geography). I am currently focusing only on the *Dyauḥ* (the celestial sphere) and the heavens! We have not yet touched upon the earthly geographical divisions.

Lecture of Prof. R. N. Iyengar (5)

The Intersection of Celestial Equators: Finding the Zero Point

The intersection of the ecliptic and the celestial equator is the equinoctial point. Because they intersect, that point serves as the zero point. One disadvantage of relying on this, however, is that over time, it keeps on changing due to precession. Therefore, you must specify the era, or the exact zero point, from which you are calculating. That is why modern astronomical software utilizes standard epochs, such as J2000 (Julian year 2000); the epoch of 2000 means the calculations are based on where the equinox was in the year 2000, and other positions are given relative to that point.

If you go back 1,000 or 2,000 years, you will arrive at an equinoctial point specific to that era. This is how modern astronomical information is structured. Now, in the Vedic period, or even in later ancient periods, what was their zero point or origin? There was no concept of a strictly mathematical zero point in coordinate geometry, but there was a definitive starting point. They selected a specific *Nakṣatra* (asterism) and declared, "This *Nakṣatra* will be the beginning—the *Ādi*—and from here we count."

They needed a counting mechanism to map the entirety of the ecliptic circle. How did they achieve this, and how did they arrive at their conclusions? It was done through continuous observation. You start today—say, observing that the Moon is in *Kṛttikā*. You keep on watching the Moon every single night. Eventually, it comes back to *Kṛttikā*. After how many days does it return? It takes 27, or perhaps 28 days. On the 27th day, it may be very near, or by the 28th day, it might have already crossed. But if you keep *Kṛttikā* as the starting point, you will clearly observe when it returns to that point.

The concept of either 27 or 28 *Nakṣatras* originates from this observational cycle. You start tracking the Moon. Perhaps you start with a *Pūrṇimā* (Full Moon) because it is easy to observe, whereas an *Amāvāsyā* (New Moon) cannot be seen. So, you observe a *Pūrṇimā* near *Kṛttikā*. You keep watching it day after day. If you start from the *Pūrṇimā*, the Moon's illumination decreases; this is the *Kṛṣṇa Pakṣa* (the waning phase). During the *Kṛṣṇa Pakṣa*, you are able to see the Moon every night. This is not the case during the *Śukla Pakṣa* (the waxing phase), because during the *Śukla Pakṣa*, you might see the Moon's arc in the western sky even in the morning, which can cause observational confusion. But in the *Kṛṣṇa Pakṣa*, there is no such confusion.

However, the Moon does not rise at the exact same time every day. If you see the *Pūrṇimā* rising in the East this evening, tomorrow the Moon will not rise at that same time, even by modern clocks. It will be roughly one *muhūrta* late—about 48 to 50 minutes, or nearly an hour late. It will also appear smaller. The next day, it will rise an hour later than the previous day and appear still smaller. This progression continues.

Another highly interesting phenomenon is that when the Moon finally returns to *Kṛttikā* 27 or 28 days later, it is *not* a Full Moon! You started with a Full Moon, and you have tracked the Moon back to its starting coordinate, but its phase has changed.

The Sidereal and Synodic Lunar Cycles

This demonstrates that there are two distinct cycles for the Moon. On the other hand, suppose an observer says, "No, I want to do a different experiment. I will start with a Full Moon, and I will track only Full Moons to see when the next one occurs." If you do this, you will see that the Moon crosses *Kṛttikā* on the 27th or 28th day. By the 29th day, you might see a *Caturdaśī* (the 14th lunar day) or a nearly full Moon. The exact *Pūrṇimā* will happen on the 30th day, or it might have already peaked on the 29th. Actually, the exact Full Moon occurs somewhere in between the 29th and 30th day. If you start with a Full Moon rising in the evening, the next exact Full Moon might peak in the morning, representing a fractional day difference.

Thus, the ancients recognized two lunar cycles. The first is the 27 to 28-day sidereal cycle (which we now mathematically know as 27 and 1/3 days), utilized in the Vedic period. The second cycle is the 29 to 30-day synodic cycle, averaging 29.5 days. Neither of these cycles yields clean integers.

In the ancient period, some traditions utilized 27 divisions, while others used 28. Initially, as per the oldest texts we possess, it was 28. They established 28 *Nakṣatras* (asterisms) to track the sidereal motion of the Moon. To map the Moon's spatial path, you absolutely need the *Nakṣatras*. However, to track the synodic phase (from Full Moon to Full Moon), you do not need the *Nakṣatras* at all. You only need to count the moonrises. The observer does not need to care about *Kṛttikā*; they can start from anywhere, ignore the background stars, and simply count that it takes 29.5 days to reach the next Full Moon. This is the synodic period, which later became formally known as the *Māsa* (month).

The *Pakṣa* System and the 15-Day Count

In the Vedic period, however, they heavily relied on the *Pakṣas* (fortnights). As I mentioned, the number 15 was highly significant. Why struggle with 29.5 or 30 days initially? First, observe the Full Moon and track when it vanishes entirely. Does it vanish on the 14th day or the 15th day? The day it vanishes is *Amāvāsyā*. If you start with the Full Moon, the 15th day is *Amāvāsyā*; therefore, *Amāvāsyā* was called *Pañcadaśī* (the fifteenth).

An observer might then say, "Today is *Pañcadaśī*. Let me see when the next Full Moon happens." They count 1, 2, 3, 4, and arrive again at 15. Thus, *Pūrṇimā* was *also* called *Pañcadaśī*! If you examine the *Taittirīya Brāhmaṇa* and other texts, both nodes are referred to as *Pañcadaśī*. You must understand the context to know which node is being referenced. This *Pakṣa* counting system did not inherently require *Nakṣatras*. They eventually integrated them, but they clearly observed the two distinct cycles: the spatial sidereal return (27-28 days) and the phase synodic return (29.5 days). These two measurements are the absolute keys to calendar-making.

In the most ancient times, tracking a *Pakṣa*—knowing when the next *Kṛṣṇa* or *Śukla* phase began—might have been sufficient for a basic lunar calendar.

The Social Determination of Seasons (*Ṛtus*)

Naturally, they soon realized that a strictly lunar calendar would not take them far enough, because food had to be grown! Agriculture depends entirely on the Sun and the arrival of the rains. How do you forecast when the rains will come? When summer starts? When winter begins? Forecasting is a fundamental human desire. Just as people today want to forecast geopolitics, the ancients desperately needed to forecast the seasons.

Everybody intuitively knows when it is hot or cold; you do not need a specialized calendar for that basic feeling. Seasons were socially and physically felt. This is the social determination of the seasons.

In the Vedas, we see variations in how seasons were classified. In some places, they mention five *Ṛtus* (*Pañca ṛtavaḥ*). Even Sāyaṇa's *Bhāṣya* frequently refers to a five-season model, often combining *Hemanta* (pre-winter) and *Śiśira* (late winter) into a single season. Conversely, one of the *Brāhmaṇas* mentions *seven Ṛtus*, because they had to add an intercalary month to align the calendars, which they treated as a seventh *Ṛtu*. Eventually, they standardized the system to six *Ṛtus*, which proved both sufficient and necessary.

The initial names given to these seasons were *Madhu*, *Mādhava*, *Śukra*, *Śuci*, and so forth. *Madhu* and *Mādhava* represented the *Vasanta Ṛtu* (Spring). Then came *Grīṣma* (Summer), *Varṣā* (Monsoon), *Śarat* (Autumn), *Hemanta* (Pre-winter), and *Śiśira* (Winter).

The Intercalation Crisis and the Vedic Narrative

The next major developmental hurdle was intercalation. With both the Sun and Moon in play, how do you synthesize their cycles so the annual calendar remains accurate for agriculture?

If you rely solely on a lunar calendar, you lose about 12 days every year relative to the solar cycle. By losing 12 days annually, within 5 years you have lost two full months! An entire season shifts out of alignment. You might expect the *Varṣā Ṛtu* (monsoon) to arrive based on your lunar count, only to find that after 5 years, the rains are nowhere to be seen.

This astronomical crisis is beautifully preserved as an *Ākhyāna* (narrative) in the *Śatapatha Brāhmaṇa*. The text describes how the seasons "went away" from the gods (*Devas*). The *Devas* and the *Asuras* both existed alongside *Prajāpati*, but the *Asuras* were succeeding brilliantly. Even before the *Devas* could till their land, the *Asuras* were already harvesting!

The *Devas* in the *Śatapatha Brāhmaṇa* narrative are bewildered: "How is it that they are already tilling, and even before our predicted rains come, they are already harvesting?" This implies that the *Asuras* were perhaps utilizing advanced irrigation or had a better grasp of the solar calendar. Some modern commentators misinterpret this ethnically, claiming the *Asuras* represent dark-skinned Harappans who knew agriculture, while the *Devas* were invading Aryan savages. This is an incorrect and anachronistic projection.

Prajāpati was the originator of both the *Devas* and the *Asuras*; he was impartial. As the *Ṛgveda Khila* (*Jitanta Stotra*) states:

"*Devānāṃ dānavānāṃ ca sāmānyam adhidevatam*"

(He is the common supreme deity of both the Devas and the Dānavas).

This narrative simply represents different groups of people—some practically engaged with the earth and observing the solar cycles accurately, while others (the *Devas* in this allegory) were theoretical or lagging behind in their astronomical tracking.

The *Devas* prayed to *Prajāpati* for help. *Prajāpati* advised them: "You must understand the *Ṛtus*. Incorporate the *Ṛtus* (seasons) into your *Yajñas* (sacrifices). If you include the solar seasons in your rituals, you will also thrive."

The Scientific Integration of Ritual and Astronomy

Following this, specific ritual offerings like the *Ṛtu-yājyā* and *Ṛtu-svāhā* were introduced. This was not merely a religious addition; it was a scientific calibration! Originally, it was absent. Later, we see an explosion of terms in the *Brāhmaṇa* texts: *Ṛtupātra*, *Ṛtugraha*, *Ṛtuyājyā*, and *Ṛtuyāji*.

The society developed specialized groups of observational ritualists. The *Darśapūrṇamāsa yājis* focused on synchronizing the lunar and solar cycles over 15 and 30-year spans. The *Ṛtuyājis* focused on tracking the seasonal shifts. The *Cāturmāsya yājis* focused on four-month solar intervals. Scientifically, these efforts were a combined, systematic endeavor to mathematically determine the exact length of the solar year, follow the Sun's transits, and reconcile them with the lunar phases.

If you examine the *Brāhmaṇa* and Vedic texts from this astronomical perspective, they contain an enormous wealth of scientific data. However, if you view them solely through a *Yājñika* (purely ritualistic) lens, or rely entirely on Western translations or literal native commentaries, the meaning is entirely lost. It makes the ancient *Ṛṣis* appear as though they were blindly performing arbitrary actions, which is entirely false.

This deep astronomical intent is also heavily encoded in the massive year-long sacrifice called the *Gavāmayana*, which scholars like Pingree have studied but often dismissed as mere ritual. I will look at the *Taittirīya Āraṇyaka* translation to elaborate further.

Lecture of R.N. Iyengar (6)

The Sidereal Adjustments and the Solar Connection

That is how it must be treated. And here, of course, the *dvivacana* (dual number) is used—an expected grammatical adjustment to the stars. However, later on, texts would state that *Aśvinī* consists of three stars in some places, depending on how they are cataloged.

Now, how does this connect with the Sun? We required this solar connection specifically for tracking the seasons. Otherwise, we would have been perfectly content relying solely on the Moon, mistakenly equating lunar *ṛtus* (seasons) with the actual agricultural seasons required for growing food, which clearly did not align with reality.

There is an important point to note here. You can theoretically maintain a strictly lunar calendar. For instance, the Islamic calendar does not recognize this solar adjustment; it is purely lunar. This is why the month of Ramadan keeps shifting every year. You might observe that the fast was in August one year, and eventually, it shifts to December. The cycles operate independently, but if you wait for about 30 to 33 years, the lunar and solar cycles will briefly coincide again.

The *Puṇya Nakṣatra* and the *Brāhma-muhūrta*

The Sun (*Sūrya*) is crucial because there are specific mantras that state:

"*Yat puṇyaṃ nakṣatraṃ tad vaṭ kurvīta upavyuṣam.*"

Those among you who study the *Yajurveda* may be familiar with this. You must fix this observation during the *upavyuṣam*. *Upavyuṣa* refers to the twilight period. While *Uṣas* is the early morning dawn, *upavyuṣam* represents the predawn period when it is still dark, but the first light is just beginning to emerge.

The text continues:

"*Yadā vai sūrya udeti*" (When the Sun is rising).

"*Atha nakṣatraṃ naiti*" (The star vanishes).

"*Yāvati tatra sūryo gacchet...*"

I have provided a translation of this passage. Let me not read it out in its entirety, but it essentially provides instructions on how this observational ritual must be conducted. What it instructs is this: in the early morning, during the twilight period, you observe a *nakṣatra*. You fix that specific *nakṣatra* as the *puṇya nakṣatra* (the auspicious asterism).

For example, you might observe *Rohiṇī*. Aldebaran is the original *Rohiṇī*. (Do not look at the triangular diagram; that depicts a later conceptualization of *Rohiṇī* comprising five stars. This refers to the original *Rohiṇī*). So, *Rohiṇī* has risen in the East. It is still *upavyuṣa*; there is faint light. You mark its position and calculate how much time remains before the Sun rises to the point where the star vanishes in the solar glare.

The *Bhāṣyakāra* (commentator) adds that you can use physical markers. You can place a *cihna* (mark) somewhere—such as erecting a pole—to track this alignment, so that when the Sun fully rises, that *nakṣatra* has vanished. Why is it designated as a *puṇya nakṣatra*? Because during that specific window of time, you must conclude all your ritual duties. Whatever tasks you intend to perform, you must complete them within that timeframe.

Historically, this observational window is what has been handed down to us today as the *Brāhma-muhūrta*. As you know, the *Brāhma-muhūrta* occurs approximately one and a half hours before sunrise. In certain northern latitudes, practitioners might even identify 3:00 AM as the *Brāhma-muhūrta*. The prevailing belief was that any endeavor undertaken during this highly auspicious period would succeed.

The Evolution of Lunar Months: *Amānta* vs. *Pūrṇimānta*

It is important to note that there were no formal "months" in the strict sense during the early Vedic period. Present-day calendrical months like *Kārttika māsa* or *Mārgaśīrṣa māsa* did not exist in that format. Instead, time was measured using *pakṣas* (lunar fortnights). The *ṛtus* (seasons) were well-defined. While the word *māsa* (month) existed, the specific month names we use today were absent. These specific names emerged only after approximately 1800 BCE. The scholar S.B. Dixit has discussed this evolution quite thoroughly in his text.

When ancient texts refer to terms like *Caitrī*, *Māghī*, or *Āṣāḍhī*, it strictly denotes the Full Moon occurring in proximity to that respective *nakṣatra*. This created a systemic issue regarding the definition of a month: should it be an *Amānta* month (ending with the New Moon) or a *Pūrṇimānta* month (ending with the Full Moon)?

If you start the month after the *Pūrṇimā* (Full Moon), the first *pakṣa* is the *Kṛṣṇa Pakṣa* (the waning phase), followed by the *Śukla Pakṣa* (the waxing phase). Conversely, in the *Amānta* system, you begin with the *Śukla Pakṣa* and then proceed to the *Kṛṣṇa Pakṣa*.

Even today, regional differences persist—for example, between the calendars used in Himachal Pradesh and those in South India. The names of the months remain identical, but the *Śukla* and *Kṛṣṇa* phases are staggered, resulting in a 15-day offset between the two systems. This discrepancy must be kept in mind, especially when studying later historical inscriptions, as the chronology requires careful calibration. Even in the North, many people use the *Amānta* system, though, as confirmed by our participant from Himachal Pradesh, the *Pūrṇimānta* system is still active there. Thus, the month starts with the *Pūrṇimā*, and the month is named after the particular *nakṣatra* near which the Full Moon occurs.

The *Nakṣatreṣṭi* and the Antiquity of the Asterisms

There is a specific ritual called the *Nakṣatreṣṭi* detailed in the *Taittirīya Brāhmaṇa*, and it continues to be performed in some places even today. The text discusses the *Amāvāsyā* and *Pūrṇimā*, the rising of the *nakṣatras*, and implicitly addresses the mathematical discrepancy between the 29.5-day synodic cycle and the 27-day sidereal cycle, although it does not state the exact fraction explicitly. But if you follow the ritual logic, the astronomical rigor becomes clear.

Let us look at the list of *nakṣatras*. These names are familiar to you. The sequence in the *Taittirīya Brāhmaṇa* begins with *Kṛttikā—Kṛttikā*, *Rohiṇī*, *Mṛgaśīrṣa*—and concludes with *Bharaṇī*. There are exactly 28 *nakṣatras* listed here, as *Abhijit* is included. However, notice how they are cataloged: the names of the *nakṣatras* are intrinsically linked with their respective *devatās* (deities).

For instance, *Agni* is the *devatā* for *Kṛttikā*. *Prajāpati* is the *devatā* for *Rohiṇī*. *Soma* is the *devatā* for *Mṛgaśīrṣa*. They are listed sequentially. This intricate mapping confirms that these assignments were mathematically and observationally rigorous.

There has been a massive controversy in Indology regarding this. Western scholars historically argued that the ancient Indians did not know the *nakṣatras* and that the entire system was borrowed from the Greeks, Babylonians, or Arabs (who called them lunar mansions or *manāzil*). This assumption is absurd. The German scholar Hermann Jacobi decisively exposed the fallacy of this argument.

Jacobi demonstrated that the *nakṣatra* system is unequivocally native to India. The *devatās* assigned to these *nakṣatras* perfectly match the astronomical properties and celestial positions of the asterisms themselves. Had the Indians merely borrowed the star catalog from the Babylonians, it would be impossible for them to seamlessly retrofit ancient Vedic deities to perfectly align with those distinct celestial coordinates. This profound alignment of *devatā* and *nakṣatra* definitively proves the antiquity and originality of the Indian observational system.

The Dual Nature of Asterisms and the Necessity of the Solar Connection

That is how it has to be treated. And here, of course, the *dvivacana* (dual number) is used—an expected grammatical adjustment for stars that appear as pairs. Later on, however, in certain places and depending on how they are cataloged, they would describe *Aśvinī* as consisting of three stars.

Now, let me go further. How is all of this connected with the Sun? We required this solar connection specifically for tracking the seasons (*ṛtus*). Otherwise, we would have been perfectly happy relying solely on the Moon. However, mistaking the lunar cycle for the actual agricultural seasons required for growing food simply does not work in reality.

There is an important point to note here: you can theoretically maintain a calendar based purely on that lunar cycle. For instance, the Islamic calendar does not recognize this solar adjustment; it is strictly lunar. That is why the month of Ramadan keeps shifting every year. The solar connection is an absolute necessity if a society wishes to lock its calendar to the agricultural seasons.

The Evolution of Months: *Amānta* vs. *Pūrṇimānta*

Actually, there were no "months" in the Vedic period in the sense of the present-day months. Names like *Kārttika māsa*, *Mārgaśīrṣa māsa*, *Phālguna māsa*, or the Tamil *Āḍi māsa* and *Thai māsa* were simply not there. Time was tracked via the *pakṣas* (fortnights) and the *ṛtus* (seasons). While the word *māsa* (month) itself existed, the specific month names we use today were

absent. They emerged only after about 1800 BCE. This evolution has been discussed quite thoroughly by S.B. Dixit in his text.

When ancient texts refer to terms like *Caitrī*, *Māghī*, or *Āṣāḍhī*, it strictly denotes the Full Moon (*Pūrṇimā*) occurring in proximity to that respective *nakṣatra*. This creates a systemic calendrical problem regarding the definition of a month: Do you utilize an *Amānta* month (ending on the New Moon) or a *Pūrṇimānta* month (ending on the Full Moon)?

If you start the month after the *Pūrṇimā* (Full Moon), the first *pakṣa* is the *Kṛṣṇa pakṣa* (the waning phase), followed by the *Śukla pakṣa* (the waxing phase). Conversely, in the *Amānta* system, you begin with the *Śukla pakṣa* and then proceed to the *Kṛṣṇa pakṣa*.

Even today, regional differences persist. For example, there are differences between the calendars used in Himachal Pradesh and those in South Indian states. The names of the months remain identical, but the *Śukla* and *Kṛṣṇa* phases are staggered, resulting in a 15-day offset. This discrepancy must be kept in mind, especially when studying later historical inscriptions—not just those from before the Common Era, but even those after. Epigraphists and scholars working on synchronizing inscriptions between the North and South have to be very careful with this. Even in the North, many people use the *Amānta* system, though the *Pūrṇimānta* system is still active in places like Himachal Pradesh. In that system, the month starts with the *Pūrṇimā*, and the month is named after the particular *nakṣatra* where the Full Moon occurs.

The Social Determination of Seasons (*Ṛtus*)

Now, if you examine the seasons, you will find variations in how they were classified. In some places, they mention five *ṛtus* (*pañca ṛtavaḥ*). Even in the *Sāyaṇa Bhāṣya*, a five-season model is frequently cited, often combining *Hemanta* and *Śiśira* into one. In other texts, six *ṛtus* are mentioned, and in one of the *Brāhmaṇas*, even seven *ṛtus* are listed because they included an intercalary month as an extra *ṛtu*. Eventually, they concluded that six *ṛtus* were both sufficient and necessary.

The initial names given to these seasons were *Madhu*, *Mādhava*, *Śukra*, *Śuci*, and so forth. *Madhu* and *Mādhava* represented the *Vasanta ṛtu* (Spring). Then came *Grīṣma* (Summer), *Varṣā* (Monsoon), *Śarat* (Autumn), *Hemanta* (Pre-winter), and *Śiśira* (Winter).

The Intercalation Crisis and the *Śatapatha Brāhmaṇa*

The next major developmental hurdle was intercalation. With both the Sun and Moon in play, how do you synthesize their cycles so the annual calendar remains accurate?

If you rely solely on a lunar calendar, you lose about 12 days every year relative to the solar cycle. By losing 12 days annually, within 5 years you have lost two full months! An entire season shifts out of alignment. You might start with the *Varṣā ṛtu*, but after 5 years you realize the rains are not happening when your calendar says they should; something else has taken its place.

This astronomical crisis is beautifully preserved as an *ākhyāna* (narrative) in the *Śatapatha Brāhmaṇa*. The text states that "the *ṛtus* went away from the gods." The *Devas* and the *Asuras*

were both existing alongside *Prajāpati*, but the *Asuras* were succeeding brilliantly. Even before the *Devas* could till their land, the *Asuras* were already harvesting! The *Devas* were bewildered: "How is it that they are already tilling, and even before the rains come, they are already harvesting?" This implies that the *Asuras* had perhaps mastered irrigation or had a better grasp of the solar calendar.

Some commentators have misinterpreted these *Asuras* ethnically, suggesting they were dark-skinned Harappans who knew agriculture, while the *Devas* were invading Aryan savages. This is an incorrect projection. *Prajāpati* was the originator of both; he did not discriminate between *Devas* and *Asuras*. As the *Ṛgveda Khila* (*Jitanta Stotra*) explicitly states:

"*Devānāṃ dānavānāṃ ca sāmānyam adhidevatam*"

(He is the common supreme deity of both the Devas and the Dānavas).

This narrative simply highlights different groups of people—some practically engaged with the earth and observing the correct solar cycles, while others (the *Devas* in this allegory) were theoretical or lagging behind. The *Devas* prayed to *Prajāpati* for help. *Prajāpati* advised them: "You must understand the *ṛtus*. Incorporate the *ṛtus* into your *yajñas* (sacrifices), and you will also thrive."

Following this, the *Ṛtu-yājyā* and *Ṛtu-svāhā* were introduced into the rituals. This was a profound scientific integration of seasonal tracking into societal practice. If you look into the *Brāhmaṇa* texts from this astronomical perspective, they contain enormous information. But if you look at it solely from a *Yājñika* (ritualistic) angle, you miss the profound scientific reality underneath.

The *Atharvaveda* and the Etymology of Stars

Regarding the *nakṣatras*, the first place in the Veda where the full list appears is in the *Atharvaveda*. All 28 *nakṣatras* are mentioned there. Something highly interesting is also recorded:

"*Bhānor āśleṣā ayanaṃ maghā me...*"

This explicitly places the *ayana* (solstice) at the *Maghā* asterism, serving as a critical chronological marker.

For the *nakṣatras*, another word frequently used in the *Ṛgveda* is *stṛ*. *Stṛ* appears in many places to mean "star." The etymology relates to swimming or crossing over (*tārayate* / *saṃsāraṃ tārayati*—that which helps one cross the ocean of existence). From this root, the word *tārā* is derived. Interestingly, even the Sun (*Sūrya*) is referred to as *stṛ* in some places.

The Shifting *Nakṣatra* Order and the *Deva Gṛhas*

In the *Taittirīya* texts, you find comprehensive descriptions and tables of the *nakṣatras*. The crucial thing you have to remember here is the fixed order: *Aśvinī*, *Bharaṇī*, *Kṛttikā*, *Rohiṇī*. However, during the period of the *Mahāsalila*, the order was different. It started with *Kṛttikā*,

went through *Rohiṇī*, ended with *Bharaṇī*, and then looped back to *Kṛttikā*. It did not start with *Aśvinī*.

This shift is a strictly chronological phenomenon. Because of the precession of the equinoxes, the *nakṣatra* that marks the vernal equinox (the start of the year) slowly changes over millennia. It takes roughly 1,000 years for the equinox to shift from one *nakṣatra* to the preceding one.

The texts also conceptualize the asterisms as the abodes of the gods. The *Yajurveda* explicitly states:

"*Devagṛhā vai nakṣatrāṇi*" (The nakṣatras are indeed the houses of the gods).

The *devatās* (deities) for each *nakṣatra* are explicitly assigned in the *Yajurveda*: Agni is the *devatā* for *Kṛttikā*, Prajāpati is the *devatā* for *Rohiṇī*, and so on.

However, you must be careful with these texts because there are chronological stratifications. The *Ṛgveda* is older, the *Yajurveda* comes later, and the *Taittirīya Brāhmaṇa* is later still. Consequently, you will find differences that must be sorted out. For example, today we say the *devatā* for *Jyeṣṭhā* is Indra, which matches the *Mahābhārata*. But in some older texts, you might see variations.

You must also pay attention to grammatical and terminological nuances. Today we call the first *nakṣatra Aśvinī*, but the ancient texts did not call it *Aśvinī*; they called it *Aśvayuj*. The text states:

"*Aśvayujau nakṣatram aśvinau devatā.*"

(*Aśvayuj* is the *nakṣatra*, and the *Aśvins* are the *devatās*).

Understanding these precise celestial alignments, deity mappings, and grammatical shifts is essential for unlocking the profound astronomical heritage preserved within the Vedic corpus.

The Evolution of the Vedic Calendar: Months, *Pakṣas*, and *Ṛtus*

Actually, there were no specific "months" in the Vedic period like the present-day months. Month names such as *Kārttika māsa*, *Bhādrapada māsa*, or the Tamil *Āḍi māsa* and *Thai māsa* did not exist in that format. The *pakṣas* (fortnights) were established, and the *ṛtus* (seasons) were well-defined. The word *māsa* (month) itself was used, but the specific *month names* as we know them today were absent.

These names only emerged after approximately 1800 BCE. This development has, in fact, been discussed quite well by S.B. Dixit in his text. When you see terms like *Caitrī*, *Māghī*, or *Āṣāḍhī*, it strictly means the Full Moon (*Pūrṇimā*) occurred near that respective star. This leads to a calendrical issue regarding the months. Do you utilize an *Amānta* month (ending on the New Moon) or a *Pūrṇimānta* month (ending on the Full Moon)?

If you start with the *Pūrṇimā*, the first *pakṣa* is going to be the *Kṛṣṇa pakṣa* (waning phase), and then the *Śukla pakṣa* (waxing phase) comes. Whereas in the *Amānta* system, you start with the *Śukla pakṣa* first, and then go to the *Kṛṣṇa pakṣa*. Even today, there is a distinct difference

between some of the calendars of Himachal Pradesh and those of the South Indian states. The month names remain identical, but the *Śukla* and *Kṛṣṇa* phases are staggered, resulting in a 15-day difference.

You have to bear this in mind, especially when studying later historical inscriptions—not just those from before the Common Era, but even those after the Common Era. Synchronizing these inscriptions has been problematic, but epigraphists and other scholars have done this work quite comprehensively. So, people working on inscriptions and sources bridging the North and South have to be highly careful. Even in the North, many people use the *Amānta* system, though, as our participant from Himachal Pradesh confirmed, the *Pūrṇimānta* system is used there. This means the month starts with the *Pūrṇimā*, and the month is named after the particular *nakṣatra* where the Full Moon occurs. This is an ancient practice.

This synchronization issue is not merely theoretical. There is one specific ritual, the *Nakṣatreṣṭi*, detailed in the *Taittirīya Brāhmaṇa*, which is still performed in some places today. The *Nakṣatreṣṭi* conceptualizes that the New Moon (*Amāvāsyā*) and Full Moon (*Pūrṇimā*) are intrinsically connected. The text addresses the 29.5-day synodic cycle versus the 27-day sidereal cycle. I don't know exactly how they mathematically reconciled it, but they were acutely aware of the difference and managed it.

The *Ṛtus*: Rhythm and Solar Alignment

The most important aspect here is that the Moon has two cycles, whereas the Sun has only one. The Moon has these two "kinds of things" which repeat.

Now, which of these do you call *ṛta*? Both are *ṛta*. The word *ṛtu* comes from *ṛta*, which signifies rhythm or periodic cosmic order. *Ṛtu* or *ṛta* initially meant only this rhythm. There can be several rhythms. Not only this; daily sunrise is also a rhythm. The Moon's phases represent another rhythm—month to month, or *nakṣatra māsa* to *nakṣatra māsa*. *Ayana* (solstice movement) is also a rhythm. These rhythmic cycles come up very clearly in the *Mahāsalila*, prompting questions like: How many *ṛtus* are there? Is it six? Or 300 *ṛtus*? Or 12 *ṛtus*?

In other words, there was a very lively, intellectual discussion in the form of differing opinions. It was not merely a difference of opinion; they finally came to a conclusion. Slowly, that conclusion solidified, and we must not mistake the final conclusion for the original, exploratory discussions that happened. We only truly understand the origins of pre-*Siddhāntic* astronomy when we trace these discussions.

The names of the *nakṣatras* are familiar to you. Today, we use almost any prominent star as a *nakṣatra*. Apart from the *Yajurveda*, even in the *Ṛgveda*, the word *nakṣatra* is used, and several specific asterisms are mentioned. For example, *Maghā* is mentioned. *Phalgunī* is mentioned, though under its ancient name, *Arjunī*. *Arjunī* was the original name for *Phalgunī*. You know that Arjuna is also called Phālguna—why? Because he was born in that *nakṣatra*. Both names apply to the *nakṣatra* as well, and we use that synonymity today. So, it was called *Arjunī*. Yesterday I mentioned the *Sūryā-vivāha Sūkta*; this event happens in the *Arjunī nakṣatra*.

Then *Tiṣya* is there as a *nakṣatra*, and *Revatī* is mentioned. It could be that it was a *nakṣatra* or something else; we don't know, as the tradition assigns different meanings to these words since Sanskrit is polysemic—you can have different meanings for the same word. So *Revatī* would mean bright; anything can be bright! *Revatī* is also the name of persons. Beings can also take their names like that. So, you have to identify from the context whether it refers to a celestial body or not.

Whereas, when you come to the Vedas (specifically post-*Ṛgveda* texts), this becomes very clear. But regarding the period before the *nakṣatras*, I mentioned the seasons. Yesterday, someone asked me about *Śarad ṛtu* and Agastya and all that. That is a *nakṣatra*, but before that, how was *Śarad ṛtu* identified?

There was no way to do that using a fixed star. It was only a social way of doing things, reacting to something extraordinary happening in the sky. If it is very hot, they would know it is *Grīṣma*. If it is raining, you would call it *Varṣā*. But the difference between the six seasons was identifiable through group discussion and observation. And that concept in the *Taittirīya Āraṇyaka* is very clearly mentioned:

"*Ṛtu-ṛtūnām nadyamānāḥ śukla kṛṣṇau ca śāstikau. Vasantau vasubhiḥ saha saṃvatsarasya savituḥ.*"

This explicitly links the seasons (*ṛtus*) with the solar cycle (*saṃvatsara/savitṛ*). The text asks: "How do we apply these? Where is this instructed?" And it continues:

"*Etadeva vijānīyāt pramāṇaṃ kālaparyaye...*"

(This alone should be recognized as the standard for the revolution of time).

If people are talking about *Vasanta ṛtu*, it implies a specific time. That means you are happy, fruits are there, birds are there, and that is *Vasanta*. That is what it says! He also mentions something more:

"*Śuklavāsā rudragaṇā grīṣmeṇa āvartate saha.*"

Grīṣma (Summer) comes along with the *Rudragaṇa*. The *Rudragaṇa* are the *Maruts*. What is this referring to? I haven't come up to the concept of meteor showers and comets in the *Ṛgveda*, but if you see, people who know it, *Maruts* are *Rudrāḥ—Rudrasūnavah* (sons of Rudra). The *Marut gaṇa* are categorized into either 49, 63, or 108. There are fantastic descriptions of this group, and they are the *Rudras*. They appear in plural. "*Sahasraśo dṛśyante*"—they are seen in thousands. In some places, it says they are remembered but not seen anymore. But this *Rudragaṇa* can be seen in the *Grīṣma* (summer). Even today, you can see the meteor showers (the Perseids or Leonids) in the summer!

When it comes to the *Varṣā* (monsoon), the texts say:

"*Varṣābhir dadataḥ saha adṛkṣo duḥkhacakṣuriva tadanvāpīta iva dṛśyate.*"

(With the rains, they [the celestial markers] become like a sorrowful eye, appearing yellowed/faded).

For Ayurvedic practitioners, this is clear: during the *Varṣā ṛtu*, eyes can become yellow or infected (*tadmā pīta iva dṛśyate*). But astronomically, during the rainy season, the stars appear faded or yellowed due to the atmospheric conditions. Then in the *Śarat*, when the sky clears:

"*Śītena avyathayatīva akṣi duḥkhotthitasyeva viprasanne kanīnike... śarad yatra upadṛśyate.*"

(Like an eye recovering from pain, the pupils become exceedingly clear... where Autumn is seen).

When *Śarat* (Autumn) comes, people say, "Look, your eyes are looking very bright, food is coming up, everything is clean." They would be talking like that. In other words, what I want to say is that the *ṛtus* were identified socially by these observable, earthly conditions. Except for two: one was the *Rudragaṇa*, and again, for the *Hemanta* (pre-winter), we see:

"*Avidūranto abhighnantīva amuto jyeṣṭham iṣumukhamiva.*"

This refers to the arrow (*iṣu*), which connects to the *Mṛgaśīrṣa* constellation (the deer pierced by the arrow, representing Sirius or the belt of Orion). These *Rudras*, the children of Rudra, possess something like an arrow (*iṣumukhamiva*).

The essential point is that they started organizing the calendar around these phenomena. They recognized that the *ṛtus* were drifting from the gods, meaning the solar seasons and lunar months were desynchronizing. To fix this, they introduced the intercalary systems, aligning the *Darśapūrṇamāsa* sacrifices with the *ṛtus* to ensure the society thrived.

The Observational Mechanics of the *Nakṣatras*

The *nakṣatras* are required, as I said, either 27 or 28 for observation. The first complete list in the Veda comes in the *Atharvaveda*. In the *Atharvaveda*, it is the *nakṣatrāṇi*; there are 28 or 29, but specifically, 28 are listed. Something highly interesting is also recorded here:

"*Bhānor aśleṣā ayanaṃ maghā me...*"

This explicitly mentions *Aśleṣā* and *Maghā* in the context of the Sun's *ayana* (solstice). And a total of 28 *nakṣatras* are provided.

For *nakṣatras*, the other word used in the *Ṛgveda* is *stṛ*. *Stṛ* appears in many places, and this is actually the root for "star." You can consider it a single star. Even *Sūrya* is called *stṛ* in some places—bright and luminous. *Stṛ* may have originally meant swimming, because from *stṛ* came *tāra*, and then *tāraka* (*tārayate*—that which helps you cross over). Even today we say *saṃsāraṃ tārayati*—you cross over. Because these stars are "carried over" in the sky, in the primordial sea or the *salila*. For this concept, you must again refer back to the *Mahāsalila*. Until then, it is some kind of celestial water (*salila*) in which the stars are traveling.

Now, in the *Taittirīya* texts, all the *Taittirīya* texts have descriptions of the *nakṣatras* in very great detail. S.B. Dixit has provided the tables for all of this; some places are confusing, and he also tries to give the numbers, but that can be confusing. However, somebody had to standardize it, and we have the data today available, at least for the most ancient period. We have done standardization for our work.

"*Nakṣatrāṇām eṣām upasta soma āhitaḥ.*"

This is again from the *Ṛgveda* (the *Sūryā-vivāha Sūkta*). If you take Soma as the Moon, he is near the *nakṣatra*. It is clearly an observational statement.

The important thing you must remember here is the *order* is the same, even to this day. You start with *any nakṣatra*, the order is: *Aśvinī*, *Bharaṇī*, *Kṛttikā*, *Rohiṇī*, *Mṛgaśīrṣa*. Whereas in the *Mahāsalilam* time, it was different. It started with *Kṛttikā*, *Rohiṇī*, etc., and ended with *Bharaṇī*, and then looped back to *Kṛttikā*. It did not start with *Aśvinī*.

We must be careful with these things. Today's sequence is different. This shift becomes a chronological marker. It is a circle, all right, but for some particular purpose, the *nakṣatra* positions were shifted. One of those reasons, as demonstrated yesterday, is that as the seasons change due to precession, the *nakṣatra* marking the equinox changes. It is very slow—each *nakṣatra* might take about 1,000 years to shift to the next point. But still, it does shift.

Slowly, when you read all these texts, you get a feeling that they definitely worshipped the *nakṣatras*, or they held *nakṣatras* in very great awe and respect. The reason being:

"*Devagṛhā vai nakṣatrāṇi.*"

This concept appears in the *Yajurveda*: "They are already the abodes of the gods (*Devagṛha*)." This *Devagṛha* concept has led to many different interpretations, but for our purpose, we will simply take it as: what are these *Devas*? They may be imaginary beings there, or you can take it as a force which is with this *nakṣatra*, because they can induce some effect on others.

Now, for all the *nakṣatras*, there are also *devatās* which I have just now mentioned. The *devatās* are given in the *Yajurveda* text. But there are differences between texts, and that difference also we have to somehow sort out. That may take quite some time. If you are entering the field for the first time, you will get totally confused, so you can't believe anything.

For example, you say that for *Aśvinī*, the *devatā* is *Aśvinī* today. For *Rohiṇī*, you will say *Prajāpati* is the *devatā*. But their *Rohiṇī* may be approximately the same as today's *Rohiṇī*, but their *concept* of *Rohiṇī* was different, and their concept of *Prajāpati* was different! Hence, the *Rohiṇī-Candra* legend, if it has to be understood, is not actually *Candra*. Today we call it *Candra* in the *Purāṇas*, but it is the *Rohiṇī-Soma* or the *Rohiṇī-Prajāpati* legend in the Vedas. That has to be seen from their perspective.

For that, the *devatās*—those things will be helpful, but you have to organize them. In other words, you must bear in mind the effect of chronology. The *Ṛgveda* is older, the *Yajurveda* comes later, the *Taittirīya Brāhmaṇa* is later, and you have to keep this in mind. Otherwise, it becomes contradictory. Something is here, whereas I see in that text something else is given!

For example, for *Jyeṣṭhā*, who is the *devatā* today? You remember who is the *Jyeṣṭhā*? *Indra*. Indra is the *devatā* for *Jyeṣṭhā*. In the *Mahābhārata* and those places also, it comes up: *Indradaivatam*. So *Indradaivatam* is there, but people have taken it as *Jyeṣṭhā*. But here, if you see, there can be differences.

"*Śraviṣṭhā viṣṇurdevatā, śroṇā nakṣatram... vasavo devatā śatabhiṣaṅ nakṣatram. Indro devatā...*"

For *Śatabhiṣak*, Indra is the *devatā* here! "*Proṣṭhapadā nakṣatram aja ekapād devatā.*" So Indra is the *devatā* for *Śatabhiṣak*. This is from the *Taittirīya Saṃhitā*.

And this kind of changes happen. But if you remember:

"*Kālābhimānī Indraḥ...*"

You get an answer. Because some kind of *Kāla* (time) they might have fixed up near that *nakṣatra*. But what is *Śatabhiṣak nakṣatra*? Today, there are 100 stars shown as *Śatabhiṣak*. But if you see the count: "*Ekam, śatabhiṣak, ekade.*" It is a single *nakṣatra*. So you have to be careful with these things; that is all what I am trying to say. You can't change that.

Now, we say that we call the *nakṣatra Aśvinī*. They didn't call it *Aśvinī*. They called it *Aśvayuk*. *Aśvayuk* is different from *Aśvinī*.

"*Aśvayujau nakṣatram aśvinau devatā.*"

Aśvinau is dual; they are the *devatās*, right? So, they knew this. But the translators have been terrible. S.B. Dixit writes: "Two beings of different forms move along, seeking their own ends. They settle the calf one after another." This is the literal meaning. This obviously refers to the Sun and Moon, that everybody more or less agrees.

"*Ṛgveda 10.85 is the Sūryā-vivāha Sūkta.*"

Parts of which are used here. "*Namo namo bhavati jāyamānaḥ... viśvānyanyo bhuvanābhicaṣṭe.*" This is the *Sūryā-vivāha Sūkta*. But this is not combining here, but the number is there. So if you read that... "*Namo namo bhavati jāyamānaḥ*" is used only as an *āśīrvāda mantra* (blessing). And you know, "*Bhāgan devebhya vidadhāt... dīrghamāyuḥ śatamānaṃ bhavatu...*" They will say and put *Akṣata* (rice) and all that. Very wonderful, beautiful. But it is connected with this number, man! And that is the eclipse!

And it clearly says two different things: the Sun and Moon are going round and round, and that is constrained by this number. And that is the eclipse. So once in 18 years, or 29 years (*ṛtūnanyo vidadhaj jāyate punaḥ*). It happens, and again it happens!

If you don't understand this, you will say: "No, sir, this is all with reference to the Moon. Once a month it may happen, or maybe only day and night. Every day it happens." But why this number? It would have been one day is sufficient. 30 would have been sufficient for that, because they use all of that.

So this is my anguish. Please compare. The *Sūryā-vivāha Sūkta* I have added in my article; it is also about eclipses. So don't take it amiss in any other manner—that eclipses were considered evil and bad and things of that kind. For our ancients, they all made some deep sense. And you know that there is no absolute "sin" concept in our culture.

There are no completely fallen *asuras*. They are all brothers; they are all forces. It is the interaction of these forces that produces the cosmos.

The Chronology of Altars and Celestial Alignment

The *nakṣatras* are needed, as I said, either 27 or 28 for observation. In the *Atharvaveda*, it is the *nakṣatrāṇi*; there are 28 or 29, but specifically, 28 are listed. Something highly interesting is also recorded here:

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The essential point is that they started organizing the calendar around these phenomena. They recognized that the *ṛtus* were drifting from the gods, meaning the solar seasons and lunar months were desynchronizing. To fix this, they introduced the intercalary systems, aligning the *Darśapūrṇamāsa* sacrifices with the *ṛtus* to ensure the society thrived.

All of this geometry was fundamentally connected with the *Dārśikī Vedī* (the altar for the New Moon sacrifice). The construction of the *Vedī* was tied directly to celestial observations. The *Baudhāyana* and *Āpastamba* texts describe this rigorously. The ritual is not mere entertainment; it is a highly accurate, choreographed representation of cosmic mechanics.

During the sacrifice, the priests perform specific actions with absolute precision. While to an uninitiated observer it might look like a mere drama—a priest holding a wooden sword (*sphya*), shouting *Vaṣaṭkāra*—every action is symbolically and astronomically calculated.

For instance, when consecrating the boundaries of the altar, the priest addresses the Northern boundary with this specific mantra:

"*Mitrāvaruṇau tvottarataḥ paridhattāṃ dhruveṇa dharmaṇā.*"

(May Mitra and Varuṇa secure you in the North with the firm/fixed law).

Why the North? Because that is the domain of *Dhruva*—the fixed Pole Star! The concept is that the altar must be anchored to the unmoving center of the heavens. The *Yajamāna* (the patron) then prays:

"*Pranayā yajñaṃ devatā vardhaya... tvannākasya pṛṣṭhe yajamāno'stu... saptarṣīṇāṃ sukṛtāṃ yatra lokaḥ.*"

(Lead the sacrifice forward, increase the deities... may the Yajamāna be on the vault of heaven... where the realm of the Seven Sages [Ursa Major] and the righteous lies).

The participants are conceptually transported to the sky. Where do they wish to go? To the *Nākasya pṛṣṭhe* (the vault of heaven), situated *Ambasya pāre* (beyond the celestial waters). What are these "waters"? It is the Milky Way. If you look at the night sky, the Milky Way flows like a river, and near it lies the Draco constellation, housing the ancient *Dhruva*. The entire earthly ritual is a geometric and spiritual map of the polar sky.

The Limits of The Vedic Zodiac and Observational Errors

The *Vyākaraṇa* or actual structure of this was a relatively broad region, but still smaller than the modern concept. If we consider only one *nakṣatra* per month, the degree of error can be very large. The error could range up to 2000 years or so because of the broadness of a single *nakṣatra*. Whereas here, we have been able to restrain it to a much tighter window of about 400 years. So, in this 400-year band, this alignment was mathematically possible.

And hence, our central argument is this: The *Māghādi* era, which is famously stated in the *Maitrāyaṇīya Āraṇyaka* (or the *Maitrī Upaniṣad*), should indeed be the central point of reference. We are not blindly projecting back to 2000 BCE; rather, we are taking 1000 BCE to 1800 BCE as the definitive epoch of the *Māghādi* system.

This was also exactly when the alignment of the *Kṛttikā* system was happening. It's the *Kṛttikā*-based *Māghādi* system. Now, this specific astronomical arrangement is preserved in the *Purāṇas*. It is repeatedly mentioned in the *Viṣṇu Purāṇa*. However, it is repeatedly recorded *wrongly* in the later *Purāṇas*, completely forgotten, or totally corrupted in the still later *Purāṇas*.

But in the *Brahmāṇḍa Purāṇa* and the *Viṣṇu Purāṇa*, it remains intact. *Vāyu Purāṇa* also preserves it, with slight textual differences, but the astronomical core is solid (*pakkā*). Just like the number 3,339 was preserved accurately in the *Brahmāṇḍa Purāṇa* (while riddled with errors in others), this observation is also solid. So, this *Purāṇic* statement also directly belongs to the same ancient era of observation.

This is how we can chronologically date these phenomena. The *Mahāsalila* also explicitly starts its calendar with *Maghā*. Later, you will see how that develops. And hence, that confirms that the *Mahāsalila* must also have an origin earlier than 1600 BCE. That is exactly what M.D. Srinivas was also telling us this morning.

Similarly, Lagadha's *Vedāṅga Jyotiṣa* starts with *Śraviṣṭhādi* (beginning with *Śraviṣṭhā*/ *Dhaniṣṭhā*), and not *Śraviṣṭhārdha* (the middle of *Śraviṣṭhā*). This means *Śraviṣṭhādi* represents a half-*nakṣatra* shift forward. A half-*nakṣatra* shift due to precession corresponds to roughly 300 years of elapsed time. And M.D. Srinivas demonstrated this visually this morning using the animation of the turning celestial clock.

(Q&A begins)

Audience Member: Any questions?

Audience Member: If the numbers are so beautifully detailed in the *Ṛgveda*, the zero must have been there even before that time. What was that?

Prof. Iyengar: It's not... No, no, that is true, numbers would have been there in the previous eras. Otherwise, these kinds of complex calculations could not exist. That is true. It was self-

existing. The numbers were self-existing. That's all I can say. They didn't need anybody to invent them; it was a self-existing framework.

Audience Member: Sir, you told about the *Atharvaveda*, which is quoting one in Odisha and one in Kashmir. Which one is popular in Kashmir?

Prof. Iyengar: The *Atharvaveda*? I mentioned the two *śākhās* (branches) of the *Atharvaveda*: the *Śaunaka* and the *Paippalāda*. The *Śaunaka* is more popular in regions like Odisha, while the *Paippalāda* branch was originally found and popularized in Kashmir.

Resolving Pre-Siddhāntic Cosmography and the North Pole

I hope that answers your question about whether they knew what was causing the pole to move. If you consider the 18-year eclipse cycle and the retrograde motion of the nodes, you must mathematically postulate a moving node. Otherwise, predicting the return of the eclipse at a specific longitude becomes mathematically impossible.

Now, regarding the cosmographic problem of identifying the central pivot of the heavens, we have seen that over several millennia, the identity of the Pole Star must change due to axial precession. Yet, the narrative core of these traditions remained largely intact. How did the ancient and medieval scholars reconcile this?

The *Viṣṇu Purāṇa* explicitly mentions *Dhruva*. It sets out an entire paradigm for the cosmos revolving around this fixed point. But the historical fact is that during the compilation of these later texts (such as the classical *Purāṇas* in the first millennium CE), the astronomical *Dhruva Tārā* of the Vedic period (Thuban) had long since moved away from the true North Celestial Pole.

There was a genuine realization of this discrepancy among astute observers. To reconcile this, some scholars suggested that perhaps the term *Dhruva* did not solely refer to the physical star but to the invisible, mathematical pole point itself. Others attempted to assign the role of *Dhruva* to whatever star was currently closest to the pole.

This kind of synthesis and preservation of knowledge can be better understood through an analogy involving architecture. The structure of these myths and models serves a purpose, similar to how an architectural blueprint dictates a building. The ancient seers established a model (a blueprint) for the cosmos, and even if the individual stars (the building materials) shifted, the structural model of the sky remained.

The *Sūrya-Siddhānta* and the Integration of Older Models

If you look at the *Sūrya Siddhānta*—which is one of the most fundamental texts of *Siddhāntic* astronomy—it presents an incredibly sophisticated mathematical model. However, it still incorporates remnants of these older, pre-*Siddhāntic* models.

For example, the *Sūrya Siddhānta* retains the concept of Mount Meru as the central axis of the Earth, aligned directly beneath the celestial pole. It uses the term *Kālābhimānī*, a conceptualization of time and the deities governing time. When the *Sūrya Siddhānta* discusses the motion of the planets, it utilizes epicycles (*Manda* and *Śīghra*), but it attributes the driving force of these epicycles to invisible, celestial winds or forces—echoing the *Vātaraṇjjūnāṃ* (wind-ropes) concept from the ancient *Maitrāyaṇīya Upaniṣad*.

This shows that the transition from Vedic observational astronomy to classical mathematical astronomy was not a sharp, disjointed break. The ancient concepts were absorbed, mathematically formalized, and given a new geometric rigor.

Conclusion: The Imperative of Indigenous Scholarship

In closing this session, I want to emphasize the imperative for indigenous scholarship. For too long, the narrative of Indian astronomy has been dictated by Western scholars who, despite their meticulous cataloging and translation efforts, often lacked the specific cultural, ritual, and domain expertise required to fully decode these texts. They frequently viewed the *Vedas* as primitive, disjointed poetry rather than the codified, observational science that they are.

It is up to scholars within this tradition, equipped with both a deep understanding of Sanskrit and rigorous training in mathematics and astronomy, to properly extract and preserve this knowledge. The *ṛṣis* left us an incredible, mathematically rigorous legacy encoded within these ancient hymns. It is our duty to read them correctly.

Lecture of Prof. R N Iyengar (8)

The Challenges of Manuscript Chronology and Evolving Zodiacs

That is how it must be interpreted. Now, concerning the *Vṛddha Garga* tradition—apart from many other keys—one essential aspect is chronology. The information contained in this text is enormous and traces back to a very ancient period. Now, in the *Lagadha Vedāṅga Jyotiṣa*, it is only a few *ślokas*, and it is primarily calculating the *tithi* and the position of the Sun. Here, it is not like that. There is a vast amount of information about how the kings were there, what they were doing, social information, astrological information, political information, and a variety of other things. Hence, this text is incredibly important.

The *Vṛddha Gārgīya Jyotiṣa* structure is like this... I will jump to the content directly. These are the chapters that are there. Tomorrow, when you look at the manuscript, you will get an idea yourself of how it is written and how it is preserved. Part of the manuscript is reproduced in the *Mahāsalilam* book which you people have got; you might have seen it already. However, you can see the complete thing tomorrow.

Now, this *Vṛddha Gārgīya Jyotiṣa* is actually an amorphous manuscript. That means it is simply a compilation of written material. That is all I can say. It goes by the name *Vṛddha Garga*, but there is no title page, and the ending colophons are different in each chapter. Sometimes *Garga* is there, *Gārgīya* is there, *Gārgya* is there. A variety of difficulties exist. With all of this, if we have to retrieve something in IKS (Indian Knowledge Systems), we have to go through that and edit it. That is the only thing that is possible. Since it had not been done so far, for the last ten years, I have been involved in this, along with some of my colleagues here, in editing it.

The Structure of the *Vṛddha Gārgīya Jyotiṣa*

Now, there are more than 125 chapters in this text, comprising about 5,000 verses (5,000 *ślokas*). What we have edited is less than about 10%; we have been able to edit that much so far. The remaining text is yet to be edited, translated, and published.

What we have done so far, I can briefly explain. I have put in red three chapters: *Ādityacāra*, *Mahāsalila*, and *Ṛtusvabhāva*. These three are critical for establishing chronology. That is the next figure that I am going to show. *Ādityacāra* details the *nakṣatras* in the seasons—the six seasons and what *nakṣatras* were visible are given. Whereas in the *Maitrāyaṇīya*, there is only *ayana* (solstice) given. *Ayana* represents the two seasons, *Varṣa ṛtu* and *Śiśira ṛtu*. Here, all the other *ṛtus* are also given, along with the corresponding *nakṣatras*. Hence, this text is far more accurate.

The *Mahāsalilam* is an almost independent book in prose, whereas these are in poetry (the *anuṣṭubh* meter). Since the book is with you, we are not considering it again today; I will not touch on this. This belongs to the *Māghādi* period, which we have already covered.

Then comes the *Ṛtusvabhāva*. It is the second part of the *Vīci jala*—this is the *Aṅga*, and this is the *Upāṅga*. The word *Upāṅga* would indicate this may be later than the core text. That means it has been added by the same school, by the same students of the *Garga* lineage. I

cannot say who is the original *Vṛddha Garga*; there is no way of knowing. The name is there—*Vṛddha Garga*—so we can call it the "School of Vṛddha Garga" or the *sampradāya* of Vṛddha Garga. His students would be called *Gārgīya*, *Gārgya*, and the text as *Gārgīya Saṃhitā*, *Vṛddha Gārgīya Saṃhitā*, or *Jyotiṣa*. Names like this have come up. There are also more than another 25 manuscripts that I have not touched upon, which are called *Gārgīya Saṃhitā*, which is *Phalita Jyotiṣa* of the later period—mostly horoscopes and other things. We are not touching that. This *Vṛddha Gārgīya Jyotiṣa* basically was selected for editing because there are no *rāśis* (zodiac signs) in this, there are no horoscopes mentioned, and there are no weekdays mentioned!

In other words, there is no *Pañcāṅga* as we know it today. The *Pañcāṅga* today includes *Nakṣatra*, *Tithi*, *Karaṇa*, *Vāra*, and *Yoga*. That is the modern *Pañcāṅga*. So there is no *vāra* (weekday) here. In the more ancient periods, what was important was *Nakṣatra*, *Karaṇa*, and *Yoga*. Later on, *Tithi* got added. *Yoga* is the same as *Muhūrta*; later on, *Tithi* was formalized. These are the four parameters. So this *Vīci jala* belongs to that group.

The Challenges of Manuscript Acquisition and Editing

The chapters that are there are very similar to what you read in the *Bṛhat Saṃhitā*. Varāhamihira's *Bṛhat Saṃhitā* has followed this template. The *Bṛhat Saṃhitā* in many places refers to *Garga* and *Vṛddha Garga*, and Varāhamihira has organized his text in a very particular, structured way.

This text, as it is available, had to be edited. If this *Ādityacāra* belongs to 1500 BCE, what happened in between? So many things have been added, subtracted; somebody has written something, somebody has removed something. And maybe in the Gupta period, it was finally copied into a manuscript format. You know that palm-leaf manuscripts cannot be kept for more than 200 years, so somebody has to rewrite, rewrite, and rewrite them. So the present manuscripts available to us—there are at least 12 manuscripts we have collected, which you can see. They are mostly paper and older paper manuscripts. We have only scans. If you want to see the original, you have to go to the libraries and see them. It will be very difficult to access them. So what we call a "manuscript" here is our scanned collection because that is what is needed for us to read, edit, and transcribe.

Now, this *Ṛtusvabhāva* is later. And that becomes very clear in the statements that are there. See, these are the *nakṣatras* which I have put up depending on what is given in the *Vīci jala*. It is almost the same as what I gave previously, except one: there is no *Abhijit* shown here. *Śraviṣṭhā* was the word, and you might hear that I use *Dhaniṣṭhā*. This identification of when *Śraviṣṭhā* became *Dhaniṣṭhā* is somewhat questionable.

In the sense, people have taken the *Vedāṅga Jyotiṣa* of Lagadha's *Śraviṣṭhā* as Beta Delphini in the modern map. In other words, for chronology, the ancient stars have been mapped onto the modern stars. Only then can I go to the computers, access the international catalog for these stars, and mathematically ask: "When were these stars in particular seasons?" Doing this identification becomes incredibly important. That is why in the table, we give the modern

names. Without knowing the modern names, there is no way of going back and doing this calculation.

This is an archaeo-astronomy exercise. Like you do Carbon-14 dating by modern methods, the material is ancient, but you use modern methods to date it. We also have to do the exact same thing here in astronomy.

The *Māghādi* Epoch and the Shifting Stars

I have given these *nakṣatras*—all 27—along with their astrophotographs here. These *ślokas* map the position of the stars or the *nakṣatras* in the various six *ṛtus*.

"Śraviṣṭhādīni catvāri pauṣṇārdhaṃ ca divākaraḥ..."

That is how it goes. *Divākara* is the Sun. *Śraviṣṭhā*—from the beginning of *Śraviṣṭhā*. Four ending with the half of *Pauṣṇa* (Revatī). So, four and a half *nakṣatras* starting from *Śraviṣṭhā*. You can see what that means: *Śraviṣṭhā*, *Śatabhiṣak*, *Pūrvabhādrapada*, *Uttarabhādrapada*, and half of *Revatī*. That is four and a half *nakṣatras*. That equates to *Śaiśire* (the *Śiśira ṛtu*).

Then:

"Rohiṇyantāni vicarat pauṣṇārdhād yāca bhānumān... māsau tau vāsantau..."

From *Revatī* to another four and a half, ending at *Rohiṇī* (*Rohiṇyantaṃ*). This is the *Vasanta ṛtu*. It proceeds exactly like this. He describes all of that.

In the *Ṛtusvabhāva* chapter, there is a slightly different way of describing the *nakṣatras*. It is not with reference to the *ṛtu* (*ṛtu* is mentioned, it is called *Ṛtusvabhāva*), but the months are also mentioned. The important thing is:

"Teṣām udagdakṣiṇaśca gacched yāvān vivasvān... tān stān pravakṣyāmi sarvān vidhānaśca vai laukikaṃ vaidikam."

He mentions the *Laukika* (civil) months and the *Vaidika* (ritual) months. This is how it is given:

"Yad revatī-ṛkṣam upaiti bhānuḥ, caitras sa māso..."

When the Sun comes to the *Revatī nakṣatra*, that is the *Caitra māsa*. That is the *Madhu māsa* in the Vedic system! Similarly:

"Vaiśākha māsopagataśca mādhavaḥ..."

Vaiśākha is *Mādhava*.

"Tadā hi bhānur bharaṇī gatasya..."

At that time, the Sun has come to the *Bharaṇī nakṣatra*.

So, this is the month he gives. And we know that these are the *ṛtus*: *Madhu-Mādhava* is *Vasanta ṛtu*, *Caitra-Vaiśākha* is *Vasanta ṛtu*. So when it is *Vaiśākha māsa*, that is the center—that is the equinox, which is going to be somewhere there. But this has changed! After this period, there

have been a lot of *Sauramāna* (solar calendar) shifts. This is the *Sauramāna* calendar. This is also a *Sauramāna* calendar, and these are all solar zodiac systems.

Both of these details are available in the paper, and you can get it. They can be dated by going back with precessional astronomy. What we have done is the following: I will verbally explain it.

Here, I start with say *Revatī* or *Aśvayuk*. This is *Vasanta*—from here to *Rohiṇī* end is *Vasanta*. Where should the Sun be? The Sun can be anywhere here. But if it is the *Vasanta ṛtu*, and this has to be the center, the equinoctial point, the longitude must be zero! It is only for that equinox point that the longitude is zero. For others, it is also important. In the *Maitrāyaṇīya*, only *Maghā* and *Śraviṣṭhā* were given. So we positioned them approximately with some dates. But there, the Full Moon was given. So I got two more *nakṣatras*. Here, all the 27 are there!

So, if I can fix it with only one or two, that would be very correct. There may be errors, and these are all visible early morning *nakṣatras*. *Abhimānika* is difficult to observe exactly; did the same person do the observation? Or was it a student? Did they do it for the whole year? One year is what they came to this conclusion on. All these questions arise. There will be errors in all of this. And again, my identification of *Dhaniṣṭhā* as Beta Delphini: is it correct or wrong? *Dhaniṣṭhā* itself is not *Śraviṣṭhā*. *Dhaniṣṭhā* is *Śraviṣṭhā* is a *paryāya pada* (synonym) only from *Amarakośa* (4th century CE onwards). In the Vedic period, there is no *Dhaniṣṭhā*; it is always *Śraviṣṭhā*. So how to identify this? All this requires cross-referencing, which I have done. By one astronomer by the name Abhyankar, who was a professor of astronomy at Osmania University. He has also written some papers. We referred to that in our work also. These are very important questions.

So what we have done: We took all of them and tried to see what the resultant error would be if I ran the sky backward from -2000 (2000 BCE) up to about 500 BCE. Where does it fit in? It is a fitting exercise! A large number of things could fall within a particular period. And also, all the *nakṣatras* should be visible! And they should lie in that circle (13 degrees 20 minutes) sector. That happens mostly in the 1300 BCE period.

That means there is an error. Suppose I say *Revatī* is at 0 degrees longitude, which is visible on the equinox day. Suppose that is wrong. There will be an error of, let's say, 10 days. Then a 10-degree error will be there. It is going out of that particular sector! Those sectors are theoretically done: equal sectors. The sky may not perfectly align with equal sectors. There will be some shifts, and the particular *nakṣatra* may not be exactly in that sector. The *ṛtu* might have already crossed over, and these people might have put it up like that.

If I take all of that into consideration, I get a period of around 1300 BCE. And there is zero error for about 60 years. Absolutely in that period, these *nakṣatras* which we have identified fit perfectly. The error can be regarding my *nakṣatra* identification also, I don't deny that. Or a single *nakṣatra* because there are multiple stars. So that is why it has to fall in that period. So some sophisticated "minimum mean square error" solution is needed! This is what you can call a minimum error solution.

A minimum error solution is what we have reported in our paper, and that targets this period. This is nearly the same as what you get for Lagadha's period, but there they take only one *nakṣatra* and argue that it is *Dhaniṣṭhā* only. And *Dhaniṣṭhā* has four stars in that constellation! Then they say it is only Beta Delphini. Why not Alpha Delphini? These are questions which Western Indologists raise.

And then they say: "You say *Śraviṣṭhādi*; what is *Śraviṣṭhā*? Varāhamihira says *Dhaniṣṭhā* he says! While only Utpala says *Śraviṣṭhā* are the same. Because the lexicon says it is the same, do we think the *Ṛṣis* also treated it like that?"

These are the important questions. And they were after observing by the rising of the stars. They did not have telescopes, they did not have longitude calculations. So it has to be the rising day they had to see. And a very peculiar thing happens here: This so-called *Dhaniṣṭhā* rises *before Aśvinī*! In other words, if you take *Dhaniṣṭhā* as *Śraviṣṭhādi* for Lagadha's period, it rises much before the Winter Solstice day. So on the Winter Solstice day, it is visible, because it has already risen. But is it the *same* longitude? Longitude coordinates and lateral coordinates are very important for visibility. If you take only longitude, it is mathematical. If you take visibility, both are important.

The longitude may be the same, but even in the night, or even in the morning, it may not be visible. The objections are there: if it is visible, you do it at the day of rising. So we have gone through all of that, and in the paper, it is all published. You can go through that. This is what Abhyankar also said: taking *Dhaniṣṭhā* as *Śraviṣṭhā* is wrong. I also agree with that. *Śraviṣṭhā* is actually *Altair*.

Later on, around 500 BCE, that was not in that place because the stars could not be seen. So they changed it. And they were seeing at that time this *Dhaniṣṭhā* in that place. The *Sūrya Siddhānta* gives some numbers for the coordinates. That has muddled up all our thinking. It gives actually *Abhijit* in the position of what is called today Vega! *Abhijit nakṣatra* records the longitude. You match it; it corresponds with Vega. Vega is far away, so many people have taken *Abhijit* as Vega.

Whereas the Jaina astronomical texts say *Abhijit* must be like a *Gośīrṣa* (a cow's head). That matches only with Aquila, what is today called *Śravaṇa*. So there is an interchange which has happened here. And *Śraviṣṭhā* means something which you have to be hearing, *Śravaṇa* is the ear. And *Delfini* looks like an ear! That is the figure which Martin has put up in that circle. And *Delfini* is being called *Dhaniṣṭhā* today. So it is the original *Śravaṇa* which was right up. So it should be the previous month that would have been Aquila!

This can be sorted out. There will be no problem if we follow the principles of astronomy, the dating, the precision, and all these analytical metrics carefully.

Concluding Q&A: Manuscript Traditions

Thank you so much. I will hand over to Sundar to continue, meanwhile, are there any questions?

Host: Any questions?

Audience Member: Sir, regarding the manuscripts you studied... Most of the manuscripts are in the Devanāgarī script, which itself shows that it is practically a reasonably late copy, right?

Prof. Iyengar: Yes, exactly. As I mentioned, these manuscripts are relatively late copies—mostly on paper, spanning perhaps the 16th to 19th centuries. The script is usually Devanāgarī, though we occasionally find regional scripts. However, the *content* and the *astronomical observations* encoded within them explicitly date back to the pre-Siddhāntic, Vedic observational epochs. We use the astronomical data as the primary chronological marker, not the physical age of the paper or the script of the scribe who copied it.

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That is how it must be interpreted. Now, concerning the *Vṛddha Garga* tradition—apart from many other keys—one essential aspect is chronology. The information contained in this text is enormous and traces back to a very ancient period. Now, in the *Lagadha Vedāṅga Jyotiṣa*, it is only a few *ślokas*, and it is primarily calculating the *tithi* and the position of the Sun. Here, it is not like that. There is a vast amount of information about how the kings were there, what they were doing, social information, astrological information, political information, and a variety of other things. Hence, this text is incredibly important.

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In other words, there is no *Pañcāṅga* as we know it today. The *Pañcāṅga* today includes *Nakṣatra*, *Tithi*, *Karaṇa*, *Vāra*, and *Yoga*. That is the modern *Pañcāṅga*. So there is no *vāra* (weekday) here. In the more ancient periods, what was important was *Nakṣatra*, *Karaṇa*, and *Yoga*. Later on, *Tithi* got added. *Yoga* is the same as *Muhūrta*; later on, *Tithi* was formalized. These are the four parameters. So this *Vīci jala* belongs to that group.

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"Śraviṣṭhādīni catvāri pauṣṇārdhaṃ ca divākaraḥ..."

That is how it goes. *Divākara* is the Sun. *Śraviṣṭhā*—from the beginning of *Śraviṣṭhā*. Four ending with the half of *Pauṣṇa* (Revatī). So, four and a half *nakṣatras* starting from *Śraviṣṭhā*. You can see what that means: *Śraviṣṭhā*, *Śatabhiṣak*, *Pūrvabhādrapada*, *Uttarabhādrapada*, and half of *Revatī*. That is four and a half *nakṣatras*. That equates to *Śaiśire* (the *Śiśira ṛtu*).

Then:

"Rohiṇyantāni vicarat pauṣṇārdhād yāca bhānumān... māsau tau vāsantau..."

From *Revatī* to another four and a half, ending at *Rohiṇī* (*Rohiṇyantaṃ*). This is the *Vasanta ṛtu*. It proceeds exactly like this. He describes all of that.

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"Teṣām udagdakṣiṇaśca gacched yāvān vivasvān... tān stān pravakṣyāmi sarvān vidhānaśca vai laukikaṃ vaidikam."

He mentions the *Laukika* (civil) months and the *Vaidika* (ritual) months. This is how it is given:

"Yad revatī-ṛkṣam upaiti bhānuḥ, caitras sa māso..."

When the Sun comes to the *Revatī nakṣatra*, that is the *Caitra māsa*. That is the *Madhu māsa* in the Vedic system! Similarly:

"Vaiśākha māsopagataśca mādhavaḥ..."

Vaiśākha is *Mādhava*.

"Tadā hi bhānur bharaṇī gatasya..."

At that time, the Sun has come to the *Bharaṇī nakṣatra*.

So, this is the month he gives. And we know that these are the *ṛtus*: *Madhu-Mādhava* is *Vasanta ṛtu*, *Caitra-Vaiśākha* is *Vasanta ṛtu*. So when it is *Vaiśākha māsa*, that is the center—that is the equinox, which is going to be somewhere there. But this has changed! After this period, there have been a lot of *Sauramāna* (solar calendar) shifts. This is the *Sauramāna* calendar. This is also a *Sauramāna* calendar, and these are all solar zodiac systems.

Both of these details are available in the paper, and you can get it. They can be dated by going back with precessional astronomy. What we have done is the following: I will verbally explain it.

Here, I start with say *Revatī* or *Aśvayuk*. This is *Vasanta*—from here to *Rohiṇī* end is *Vasanta*. Where should the Sun be? The Sun can be anywhere here. But if it is the *Vasanta ṛtu*, and this has to be the center, the equinoctial point, the longitude must be zero! It is only for that equinox point that the longitude is zero. For others, it is also important. In the *Maitrāyaṇīya*, only *Maghā* and *Śraviṣṭhā* were given. So we positioned them approximately with some dates. But there, the Full Moon was given. So I got two more *nakṣatras*. Here, all the 27 are there!

So, if I can fix it with only one or two, that would be very correct. There may be errors, and these are all visible early morning *nakṣatras*. *Abhimānika* is difficult to observe exactly; did the same person do the observation? Or was it a student? Did they do it for the whole year? One year is what they came to this conclusion on. All these questions arise. There will be errors in all of this. And again, my identification of *Dhaniṣṭhā* as Beta Delphini: is it correct or wrong? *Dhaniṣṭhā* itself is not *Śraviṣṭhā*. *Dhaniṣṭhā* is *Śraviṣṭhā* is a *paryāya pada* (synonym) only from *Amarakośa* (4th century CE onwards). In the Vedic period, there is no *Dhaniṣṭhā*; it is always *Śraviṣṭhā*. So how to identify this? All this requires cross-referencing, which I have done. By one astronomer by the name Abhyankar, who was a professor of astronomy at Osmania University. He has also written some papers. We referred to that in our work also. These are very important questions.

So what we have done: We took all of them and tried to see what the resultant error would be if I ran the sky backward from -2000 (2000 BCE) up to about 500 BCE. Where does it fit in? It is a fitting exercise! A large number of things could fall within a particular period. And also, all the *nakṣatras* should be visible! And they should lie in that circle (13 degrees 20 minutes) sector. That happens mostly in the 1300 BCE period.

That means there is an error. Suppose I say *Revatī* is at 0 degrees longitude, which is visible on the equinox day. Suppose that is wrong. There will be an error of, let's say, 10 days. Then a 10-degree error will be there. It is going out of that particular sector! Those sectors are theoretically done: equal sectors. The sky may not perfectly align with equal sectors. There will be some shifts, and the particular *nakṣatra* may not be exactly in that sector. The *ṛtu* might have already crossed over, and these people might have put it up like that.

If I take all of that into consideration, I get a period of around 1300 BCE. And there is zero error for about 60 years. Absolutely in that period, these *nakṣatras* which we have identified fit perfectly. The error can be regarding my *nakṣatra* identification also, I don't deny that. Or a single *nakṣatra* because there are multiple stars. So that is why it has to fall in that period. So some sophisticated "minimum mean square error" solution is needed! This is what you can call a minimum error solution.

A minimum error solution is what we have reported in our paper, and that targets this period. This is nearly the same as what you get for Lagadha's period, but there they take only one *nakṣatra* and argue that it is *Dhaniṣṭhā* only. And *Dhaniṣṭhā* has four stars in that constellation! Then they say it is only Beta Delphini. Why not Alpha Delphini? These are questions which Western Indologists raise.

And then they say: "You say *Śraviṣṭhādi*; what is *Śraviṣṭhā*? Varāhamihira says *Dhaniṣṭhā* he says! While only Utpala says *Śraviṣṭhā* are the same. Because the lexicon says it is the same, do we think the *Ṛṣis* also treated it like that?"

These are the important questions. And they were after observing by the rising of the stars. They did not have telescopes, they did not have longitude calculations. So it has to be the rising day they had to see. And a very peculiar thing happens here: This so-called *Dhaniṣṭhā* rises *before Aśvinī*! In other words, if you take *Dhaniṣṭhā* as *Śraviṣṭhādi* for Lagadha's period, it rises much before the Winter Solstice day. So on the Winter Solstice day, it is visible, because it has already risen. But is it the *same* longitude? Longitude coordinates and lateral coordinates are very important for visibility. If you take only longitude, it is mathematical. If you take visibility, both are important.

The longitude may be the same, but even in the night, or even in the morning, it may not be visible. The objections are there: if it is visible, you do it at the day of rising. So we have gone through all of that, and in the paper, it is all published. You can go through that. This is what Abhyankar also said: taking *Dhaniṣṭhā* as *Śraviṣṭhā* is wrong. I also agree with that. *Śraviṣṭhā* is actually *Altair*.

Later on, around 500 BCE, that was not in that place because the stars could not be seen. So they changed it. And they were seeing at that time this *Dhaniṣṭhā* in that place. The *Sūrya Siddhānta* gives some numbers for the coordinates. That has muddled up all our thinking. It gives actually *Abhijit* in the position of what is called today Vega! *Abhijit nakṣatra* records the longitude. You match it; it corresponds with Vega. Vega is far away, so many people have taken *Abhijit* as Vega.

Whereas the Jaina astronomical texts say *Abhijit* must be like a *Gośīrṣa* (a cow's head). That matches only with Aquila, what is today called *Śravaṇa*. So there is an interchange which has happened here. And *Śraviṣṭhā* means something which you have to be hearing, *Śravaṇa* is the ear. And *Delfini* looks like an ear! That is the figure which Martin has put up in that circle. And *Delfini* is being called *Dhaniṣṭhā* today. So it is the original *Śravaṇa* which was right up. So it should be the previous month that would have been Aquila!

This can be sorted out. There will be no problem if we follow the principles of astronomy, the dating, the precision, and all these analytical metrics carefully.

Concluding Q&A: Manuscript Traditions

Thank you so much. I will hand over to Sundar to continue, meanwhile, are there any questions?

Host: Any questions?

Audience Member: Sir, regarding the manuscripts you studied... Most of the manuscripts are in the Devanāgarī script, which itself shows that it is practically a reasonably late copy, right?

Prof. Iyengar: Yes, exactly. As I mentioned, these manuscripts are relatively late copies—mostly on paper, spanning perhaps the 16th to 19th centuries. The script is usually Devanāgarī, though we occasionally find regional scripts. However, the *content* and the *astronomical observations* encoded within them explicitly date back to the pre-Siddhāntic, Vedic observational epochs. We use the astronomical data as the primary chronological marker, not the physical age of the paper or the script of the scribe who copied it.

Second Part of the Lecture (8)

The *Vṛddha Garga* Text and the Missing *Rāśis* (Zodiac Signs)

Let's begin. If you examine the *Vṛddha Garga* text, you'll see it is quite distinct. This text is important not merely for its astronomical data but also for its broader chronological and social information. It belongs to a very ancient period, and the wealth of information it contains is enormous.

Now, in texts like Lagadha's *Vedāṅga Jyotiṣa*, there are only a few *ślokas* (verses), and they are primarily concerned with calculating the *tithi* (lunar day) and the position of the Sun. Here, however, it is entirely different. There is a vast amount of information regarding the lineage of kings, what they were doing, alongside rich social, astrological, and political data. Hence, this text is of paramount importance.

Tomorrow, when you have a chance to look at the manuscript yourself, you will get a clear idea of how it was written and preserved. A part of this manuscript is actually reproduced in the *Mahāsalila* book you received; you might have already seen it there. You can view the complete text tomorrow.

Now, the *Vṛddha Gārgīya Jyotiṣa* is what we might call an amorphous manuscript. It is essentially a compilation of written material. It goes by the name *Vṛddha Garga*, but there is no title page, and the ending colophons differ from chapter to chapter. Sometimes it says "Garga," sometimes "Gārgīya," sometimes "Gārgya"—which presents a variety of analytical difficulties. To retrieve meaningful data for the study of Indian Knowledge Systems (IKS), we have to rigorously go through the text and edit it. That is the only viable path forward.

Since this had not been systematically done before, I, along with some of my colleagues here, have been involved in editing it over the last 10 years. The text contains more than 125 chapters, comprising about 5,000 verses. So far, we have managed to edit less than 10% of it. The rest remains to be edited, translated, and published.

I will briefly explain what we have accomplished so far. I have highlighted three critical chapters in red: *Ādityacāra*, *Mahāsalila*, and *Ṛtusvabhāva*. These three chapters are crucial for establishing chronology, and they are the focus of the next figure I will show.

The *Ādityacāra* details the positions of the *nakṣatras* across the six seasons (*ṛtus*). It clearly describes which *nakṣatras* were visible during each season. In contrast, texts like the *Maitrāyaṇīya* only mention the *ayana* (solstice), which represents just two seasons: the *Varṣā ṛtu* (monsoon) and the *Śiśira ṛtu* (winter). The *Vṛddha Garga* details all the *ṛtus* alongside their corresponding *nakṣatras*, making it far more accurate for chronological dating.

The *Mahāsalila* is practically an independent prose work, while the others are written in the *Anuṣṭubh* meter. We won't delve deeply into the *Mahāsalila* again today, as the text is already with you, but remember that it belongs to the *Māghādi* period we discussed earlier.

Then comes the *Ṛtusvabhāva*. This forms the second part of what is called the *Vīci jala*. The first part is considered the *aṅga* (main body), and this is the *upāṅga* (supplementary part). The term *upāṅga* suggests it may be a later addition to the core text, likely appended by scholars belonging to the same *Garga* lineage or school (*sampradāya*). We have no way of identifying the original historical figure of Vṛddha Garga, but the school carried his name.

There are over 25 other manuscripts bearing the name *Gārgīya Saṃhitā*, but they deal primarily with *Phalita Jyotiṣa* (predictive astrology/horoscopy) from a later period. We are not touching those. We specifically selected the *Vṛddha Gārgīya Jyotiṣa* for editing precisely because **there are no *rāśis* (zodiac signs) mentioned in it, no horoscopes are discussed, and there are no *vāras* (weekdays) mentioned!**

In other words, it predates the modern *Pañcāṅga* system, which consists of *Nakṣatra*, *Tithi*, *Karaṇa*, *Vāra*, and *Yoga*. In the ancient period, the focus was strictly on *Nakṣatra*, *Karaṇa*, and *Yoga* (which was synonymous with *Muhūrta*). *Tithi* was formalized later. These are the parameters of the *Vīci jala* group.

The Shift from *Śraviṣṭhā* to *Dhaniṣṭhā*

The chapters here heavily influenced Varāhamihira, who followed this exact template when structuring his *Bṛhat Saṃhitā*. In many places, the *Bṛhat Saṃhitā* explicitly refers to Garga and Vṛddha Garga.

Editing this text presents a major chronological challenge. If the *Ādityacāra* dates back to 1500 BCE, what happened in the intervening millennia? Scribes added and removed material, and it was likely recopied into a more modern manuscript format during the Gupta period. Since palm-leaf manuscripts deteriorate within a couple of centuries, they had to be constantly rewritten. We currently have access to scans of about 12 older paper manuscripts.

The *Ṛtusvabhāva* chapter is clearly a later addition, as evidenced by its internal statements. Here, the *nakṣatras* are listed as per the *Vīci jala*. It is almost identical to the previous list I provided, with one notable exception: *Abhijit* is absent.

Furthermore, the text uses the word *Śraviṣṭhā*. You may have noticed me occasionally using the term *Dhaniṣṭhā*. The identification of exactly when *Śraviṣṭhā* became known as *Dhaniṣṭhā* is highly questionable. In identifying Lagadha's *Vedāṅga Jyotiṣa*, scholars mapped *Śraviṣṭhā* onto the modern star Beta Delphini. This process—mapping ancient asterisms onto modern international star catalogs—is absolutely essential for archaeoastronomy. Only by doing this can we use computers to mathematically calculate when these specific stars aligned with particular seasons. Without the modern names, we cannot back-calculate the dates.

Let's look at how the text maps the *nakṣatras* across the seasons:

"Śraviṣṭhādīni catvāri pauṣṇārdhaṃ ca divākaraḥ..."

(The Sun, starting from *Śraviṣṭhā*, traverses four [nakṣatras] and half of *Pauṣṇa*...)

Divākara is the Sun. *Pauṣṇa* refers to the *Revatī nakṣatra*. So, the Sun traverses four and a half *nakṣatras* starting from *Śraviṣṭhā*: *Śraviṣṭhā*, *Śatabhiṣak*, *Pūrvabhādrapadā*, *Uttarabhādrapadā*, and half of *Revatī*. This precise 4.5 *nakṣatra* transit constitutes the *Śiśira ṛtu* (Winter).

Then it continues:

"Rohiṇyantāni vicarat pauṣṇārdhād yāca bhānumān... māsau tau vāsantau..."

(From the half of *Pauṣṇa* to the end of *Rohiṇī*... these are the two months of Spring).

From the middle of *Revatī* covering another four and a half *nakṣatras* and ending exactly at the close of *Rohiṇī*—this defines the *Vasanta ṛtu* (Spring). This meticulous, mathematically precise description of the Sun's transit defines their calendar.

In the *Ṛtusvabhāva* chapter, the description shifts slightly to include month names (*māsas*):

"Teṣām udagdakṣiṇaśca gacched yāvān vivasvān... tān stān pravakṣyāmi sarvān vidhānaśca vai laukikaṃ vaidikam."

He explicitly differentiates between the *Laukika* (civil) and *Vaidika* (ritual) calendrical rules.

"Yad revatī-ṛkṣam upaiti bhānuḥ, caitras sa māso..."

(When the Sun approaches the *Revatī* asterism, that month is *Caitra*).

Caitra corresponds to the *Madhu māsa* of the older Vedic system.

"Vaiśākha māsopagataśca mādhavaḥ... tadā hi bhānur bharaṇī gatasya..."

(*Vaiśākha* corresponds to *Mādhava*... at that time, the Sun has gone to *Bharaṇī*).

We know that *Madhu* and *Mādhava* (or *Caitra* and *Vaiśākha*) constitute the *Vasanta ṛtu* (Spring). During *Vaiśākha*, the Sun is at the center of the equinox. However, due to precession,

this alignment has shifted significantly over time. These texts represent an ancient *Sauramāna* (solar) zodiac system.

Lecture of Prof. R. N. Iyengar (9)

The Vedāṅga Jyotiṣa and the Dating Controversy

And the remaining manuscripts, in fact, you can see in Kuppanna Śāstrī's edition of the INSA. There also, he cannot say what the connection is between this and the Vedas, if you read that introduction. The only thing that is available is a tradition. And there is a 5-year Yuga which is mentioned, and there is *Śraviṣṭhādī* which is mentioned there, and based on it, they try to date and got the date of about 1300 to 1400 BCE.

Now, the objections to that—that it does not really belong to the Vedas or Vedāṅga, or that it is not so old—have been raised by Pingree and others, to which MDS was also mentioning. The main reasons are two. One is: which is Śraviṣṭhā? Can you identify Śraviṣṭhā in the sky? That was the question. Nobody has answered that satisfactorily for the more ancient period. Now, some people are putting it forth and all that. So Pingree's—one of the questions was: this Śraviṣṭhā, Dhaniṣṭhā, and Śravaṇa, they are all together; they have more or less the same meaning. They might have mistaken Dhaniṣṭhā for Śraviṣṭhā or Śravaṇa for Śraviṣṭhā.

Again, the reason is that in the *Mahābhārata*, there is a śloka which comes: "*Abhijit spardhamānā tu rohiṇyā... jyeṣṭhatvam icchantī tapas taptuṃ vanaṃ gatā*." That means Abhijit—she competed with her elder sister Rohiṇī, so she wanted to become the elder. That is, the *jyeṣṭhā* (elder) is Rohiṇī, actually. And hence, she went to the forest to do *tapas*. Actually, it implies "she fell down"; she went to the forest to do *tapas*.

At that time, "*Dhaniṣṭhādis tathā kālaḥ brahmaṇā parinirmitaḥ*" is what comes in the next śloka. But in some of the editions, it is *Dhaniṣṭhādis tathā kālaḥ* that comes. In another edition, *Śravaṇādis tathā kālaḥ* comes. So, there is a *pāṭhāntara* (variant reading). It is available in the BORI critical edition; you can see that. And that is also later combined with the Triśaṅku episode, you know, where Viśvāmitra wanted to send Triśaṅku to the sky, and another formation happened and all that. So, those interesting stories are all there together.

Asterism Identifications and Astrometry

And in that connection, people have pointed out—the Western Indologists, particularly—that even in the *Mahābhārata*, if you say that *Śraviṣṭhādī* is there, it can be Dhaniṣṭhā, it can be Śravaṇa. How do you say that, because there are *pāṭhāntaras*? Which reading do you say is the correct one? And the identification of Śraviṣṭhā with Dhaniṣṭhā has been done only as a *paryāya pada* (synonym), as yesterday I was mentioning and quoting.

Regarding Dhaniṣṭhā's identification, in fact, many of these people have taken it as Delphini (Beta Delphini and Alpha Delphini). I showed that asterism also. So, the Delphinus asterism, the modern one, you can see clearly. And that was fixed up; Kuppanna Śāstrī and others who wanted to date it, they took it as Delphini. If you see the INSA book, you will see that. And their reason for selecting that, or the evidence for taking that, is purely *Sūrya Siddhānta*.

Sūrya Siddhānta gives the longitudes of the 28 stars, not 27. And the available *Sūrya Siddhānta* is an *Aśvinyādī* system. The first star in the *Sūrya Siddhānta* is Aśvinī—not Kṛttikā, not Śravaṇa, not Śraviṣṭhā, whatever it is. And it gives 28, and Abhijit is included in that. So, it would seem that there was an older text that has been edited, and a new *Sūrya Siddhānta* from somewhere around the 10th century is what we have today. The older *Sūrya Siddhānta* is not available.

And in that, the longitude of Śraviṣṭhā is given. He calls it Śraviṣṭhā; some editions may have changed it to Dhaniṣṭhā, but he gives it as Śraviṣṭhā. And that matches with Delphinus. If you take that longitude, it matches with the modern Delphinus. And hence people assumed that it can be taken as the value, and then they proceeded to dating. There is nothing wrong in that. There will be no errors because the longitude is correct. Because longitude, as you can see, is only the position along the ecliptic. Whether it was visible or not at a particular place depends on other conditions: the latitude, what its critical altitude was on the winter solstice day. Was that the first *nakṣatra* which rose up? These questions come up.

Abhyankar had analyzed this first, initially. We have done that further in our publication on dating the *Vedāṅga Jyotiṣa*, which I briefly studied and showed. So, if you want to know this controversy between Dhaniṣṭhā and Śraviṣṭhā, you have to go through that systematically and read it. And it can be shown that Śraviṣṭhā is only Aquarii, Aquarius—or what we call Beta Aquarii, Epsilon Aquarii, and Alpha Aquarii.

Precession and the Changing Shapes of Constellations

Because of precession over about 2,000 years, their relative positions have also changed; the asterism shapes have also changed. Just like the Śiśumāra changed its shape—shape changing means as we see it from Earth. And regarding Dhruva, in my paper I have written: originally it was called Śiśumāra; later on, some people called it Nahuṣa, some people called it Ajagara, some people called it... there is one more name which comes, Sarpa. And the Chinese called it a Dragon and I don't know other names, these are also set up, because the shape is changing.

Yes, in the *Viṣṇusahasranāma Bhāṣya* of Śaṅkarācārya, there is a *vṛtti* (commentary) by one of his *śiṣyas*; he says "*saraṭa godhākṛtiḥ*". Śiśumāra looks like a *saraṭa godhākṛtiḥ* (shape of an iguana/lizard)! How can it happen? It has totally changed its shape. Whereas Śaṅkara says "Śiśumāra" only. And to situate Dhruva, he says, "*saraṭa godhākṛtiḥ ākāraḥ jalajantu viśeṣaḥ tasya pucche dhruvaḥ sthitaḥ iti*" (It has the shape of an iguana, a specific water creature; at its tail, Dhruva is situated). So, there is a *vṛtti* on his *ācārya*; it is not an original commentary on that, so he's trying to explain it. And he was in the 16th or 17th century. By that time, the shape had changed so much, you know. So, you have to read these things astronomically, you get a feeling.

The Concept of Tithi: Indigenous or Imported?

I am telling all this because for the *Ārca Jyotiṣa* and Lagadha's work, linking it with the Vedas is very difficult. And one more reason, there is a last śloka in the *Yājuṣa Jyotiṣa* where... "*Bṛhaspatī mīnagatau*" or some such śloka comes, I don't remember now. That means

Bṛhaspati—that is Guru, Jupiter—is in Mīna (Pisces), under some condition. Now, the name Mīna may be Sanskrit, but was the Mīna *rāśi* (zodiac sign) available? And in fact, Kuppanna Śāstrī and others take it as an interpolation. It was interpolated later on, but... somebody had added it. It is very common, as I said, for their own personal notes, somebody may write it and keep it there, you know; later on, we think that is the original. That could have happened.

But Pingree and others pointed out, "Look, this can only belong to about 500 BCE, not earlier than that." And hence all the difficulties and the controversies with that. So he would say that even the concept of *tithi* is not Indian. Pingree's argument is that *tithi* is not Indian. It has come from the Babylonians to India. Now, it's a very big issue. About the Babylonian clay tablets and all that they have studied, he writes that these numbers cannot be understood without the concept of "*tithi*"—puts it within quotes—which is a Sanskrit word, he says. If you can, read his book; that can be downloaded also. He doesn't want to say it has come from India or whatever, he doesn't want to say that.

Now, this has been picked up by Pingree and others who are their *śiṣyas*. He says, "Look, the concept of *tithi* is not there in the Veda, the word is not there in the Vedas." And since Lagadha uses the word *tithi*, it can only have come from outside. The argument is that, or show in the Vedas where the word *tithi* is used. There is one case which I have put up in my book: only in the *Śatapatha Brāhmaṇa*, in that Matsyāvatāra episode which comes—that is Manu's flood—there is a *yat tithiṃ yat tithiṃ*... it comes. I have given the quotation; you can read that yourself.

The word *tithi* is there. But Eggeling, who translated the *Śatapatha Brāhmaṇa* into English—that is the standard even to this day, three volumes, huge book, available for downloading freely—he omits the word *tithi* in his translation. Now, I have given this quotation also in *Mahāsalilam*; you have to see these things if you are interested in understanding what the arguments are and why it goes like this.

Yes, this is on page 45 in the *Mahāsalilam* book: "*tithi*" and the "*karaṇa*" which is there. And in the footnote, I have given "*sa yat tithiṃ tat samāṃ paridideśa tat tithiṃ samāṃ nāvam upakalpya upāsāñcakre*"—you see, this is the *Śatapatha Brāhmaṇa*. Now, I mentioned that Eggeling, in his widely referred translation, left out the word *tithi* that occurs twice for unspecified reasons; he doesn't say why he has left out the word *tithi*. You can read his translation also; I think in my paper I have given the translation, not in the footnote.

Grammatical Debates and Etymology

Now, with these difficulties, if you proceed... In the book by Dīkṣit, he discusses *tithi*; you can see that. And he quotes one sentence from the *Aitareya Brāhmaṇa*—"*sthitim*" is the word which is there; he thinks it can be taken as *tithi*. Now, people have pointed out that in the *Kauṣītaki Brāhmaṇa* the same sentence comes, and there it is very clearly "*sthitim*"; it cannot be read as *tithi*. In our work also, I referred to that and showed that.

But then, is the word *tithi* Sanskrit or not? The *vaiyākaraṇas* (grammarians), they don't enter into these discussions; they are happy with whatever they are doing, they don't want to say anything. Then they will say *tithi* comes from—the standard answer is... there is one *Kāśikā*

vṛtti, I don't remember that. It gives the *pratyayas* (suffixes). It is the *tithuk pratyaya*. "From the *tithuk pratyaya*, *tithi* is derived" is the standard answer.

Now, these *pratyayas* and all these things, they may be later. The argument is that. Even the *dhātus* (roots), many of them can be later; the word might have been there, and from the word you might have derived a *dhātu*. So how do you say that the *dhātus* were all hanging somewhere and from out of them you constructed these words? It seems like that for many of them. I told you initially, there is a controversy even in the *Nirukta*, that Śākaṭāyana and others thought all words come only from *dhātus*; there are the roots, and from that... And the roots are what? You have to think of "*dudhāñ dhāraṇapoṣaṇayoḥ*", "*ḍukṛñ karaṇe*"; these "*kṛñ*", "*gṛñ*", these are the *dhātus*. How do you say that "*tithuk*" belongs to that and you got *tithi*? Problematic issues.

So this controversy, the Indological controversy—the Indologists' controversy is not meaningless, let us understand that. We may get angry and say, "Okay, these white people, they are against us, they wrote this..." It is not like that; there is a logic in what they are arguing. Because they are looking at us from an outside perspective. They are looking at our culture, our texts, our tradition, our knowledge as outsiders. They see only the outer thing, and that is what they can comment on. And why should we get upset with that? If we are sitting inside, and we think they are hurting us, we should show them the right thing.

Usage of *Tithi* in the Epics

In the *Mahābhārata*, the word *tithi* comes. And *tithi* and *titha* both come. It is used both in *puṃliṅga* (masculine) and *strīliṅga* (feminine). The common word *tithi* that we use is generally used in *strīliṅga* nowadays; nobody knows about *tithaḥ* in the *puṃliṅga*. But *bahutitha*, *tithayaḥ*, and all those usages are there in the *Mahābhārata* also. And it only means "*titha*" is something like a limit. That you can go even in space—that from here to here, that is the end, like that. In the years, in time also, you can use the same thing like *tithi*; that is the common thing.

But what people argued: "*Tithi*, you see, I know now the Pañcamī *tithi*, Ṣaṣṭhī *tithi*, Navamī *tithi*, that is what has to be *tithi*..." No, that is a wrong argument again. Even in the *Mahābhārata*, the word in that sense comes only once, in the falling of Kumāra, as the Kārttikeya, on *mahātithi ṣaṣṭhī*—on the sixth day, which is called the *mahātithi*, that's all. It doesn't say anywhere somebody was born on a Pañcamī *tithi* or Ṣaṣṭhī *tithi* or Navamī *tithi*.

Even for Yudhiṣṭhira's event, it is given as *pūrṇā*; that day was cited as *pūrṇā*. And even when they went to the forest, the Kārttikyām says *navamyām* (on the ninth) or something it comes. The word *tithi* as an appellation is not there. It is sufficient if you count one, two, three, four; why do you want the extra thing as *tithi*? It was not needed; they did not have it. All this controversy arose after Varāhamihira's time, when they took a 12-degree separation as a *tithi* definition. So, in science, definition is very important. These are all technical words, and it has to be defined, and in that sense only you can use it. If you miss that, you get wrong answers.

So, for the Siddhāntic period, that may be okay, you do whatever you want; and in the *pañcāṅga* you put something, okay, you do that. You have *tithipatras* now, they call it; fine, you have it,

and that *tithi* will have no meaning. Did people observe their birthday based on the *tithis* in the ancient period? You have to question. They had a count, no doubt. But did they use the word *tithi* there? These are important issues if you want to retrieve history as insiders. And there are so many variations, yes.

Q&A: *Tithi*, *Atithi*, and Etymological Complexities

User: So, this Rāmanavamī and Aṣṭamī...

Speaker: Yeah, yeah, I know, tomorrow it is going to come. "*Caitre navamike tithau*" right... That is a later work. That part is a later work. It does not belong to the pre-Siddhāntic period. Rāma could be pre-Siddhāntic, I am not questioning that. But in the *Rāmāyaṇa*, Rāma was born on Navamī; that is—where else is *tithi*, tell me? If you can show me, we will argue on that. Later, not today.

User: But if *tithi* was not there, then how the word *atithi* came? ... *Atithi*.

Speaker: *Atithi*... okay, good question. Good question. In fact, this is what Pāṇḍuraṅgī-jī refers to in his foreword. *Atithi* was already there, and from that, *tithi* could have come. In fact, in one of my papers also I have written. But it's very tough to argue further, you know, I will say that. Because it says "*na tithiḥ atithiḥ*" you can say, as per modern *vyākaraṇa*. Modern *vyākaraṇa* means the one which is in *caltī* (current usage) in the *vyākaraṇa*; no, as a *nañ* (negative particle), you have to take that *pratyaya*, and hence it comes.

But many of the Sanskrit words, you see, they can be derived in several ways, and they can give different meanings also. So, one has to be very careful. Now, you have the word *āstika*, and you have the word *nāstika*. But *na astika* should be *anāstika*, right? *Na ācāra* is *anācāra*. So *na astika* could be taken as *anāstika*, but *anāstika* means what? "*A*" is opposite; "*na astikaḥ anāstikaḥ*" you can say. It leads to what they would call a regression—*anavasthā doṣa*. Hence, you know, there is a never-ending thing, so they say, "No, no, no, you should not interpret it like that," there is a different thing they will tell. Fine, I have no objection to those things.

But in the Veda, how to do these Vedic words? If you see the word *atithi*, at least Sāyaṇa's explanation in many places is that one of the things is *na tithiḥ*, it comes on an arbitrary date. That means the word *tithi* should be taken as some kind of a dating here. He says it is derived from the word *at*, *atati*; *atati* means he is roaming, you know. So, one who keeps on roaming; he doesn't have any place to stay. You have to imagine this in the more ancient period: there were two groups of people, the *yāyāvaraḥ* (nomads) and the other one is the *sthāvaraḥ* (settled). So, nomads and people who were living in villages or whatever. 5,000 years back or whatever, not today. Even today, we have nomads who are there, you know, some of them; they shift from place to place. So, he derives that word *atithi* in that sense. One who doesn't have any place, he simply keeps on going, and sometimes he rests in front of my house; you should give him food. Because he is an *atithi*, has come without any appointment or nothing, there's no reason, nothing, he simply comes, so you have to feed him. Because he will go away further. That is the interpretation in some of the places which is given.

So, you have to be a little bit careful on that. But in the *Śatapatha Brāhmaṇa*, as I said, the word *tithi*—he doesn't say what is that, but he says "*yat tithau tat samām*"—on some date in which, in that year, the fish came as promised, is what the meaning is.

Conclusion and Structure of the Text (*Mahāsalilam*)

Okay, I think I have given you the introduction to this sufficiently. And hence, you have to see this text in the right perspective. Now I have covered all this, let me go quickly. The differences between pre-Siddhāntic and Siddhāntic, and one good thing I have put here... like astronomy is two branches, astrology is also two. There is a pre-Horā astrology and the Horā astrology. So, Vedic astrology is pre-Horā. Please remember that. Because Jyotiṣa is now divided into three streams: *saṃhitā*, *gaṇita*, and *horā*. So, the astronomy that we are talking about, Vedic astronomy and all that, it is pre-*gaṇita*—some *gaṇita* has started, all that. But *horā* is not there; it is pre-*horā*. And why that also we will see, and *Mahāsalilam* represents both, is what is my try.

These are the manuscripts... tomorrow you can go and see them if you are interested further. This division I have already given yesterday also I showed you. This dating also I gave. The important thing you have to bear in mind, you need not worry even about how you got and all those details, it contains a period of about 1,000 years in some manner it has.

These are the contents. The content is very simple, out of that enormous corpus now an independent book has been produced, that is what you have to understand. And the foreword you have to read, people who know Sanskrit they should read Pāṇḍuraṅgī, even otherwise you will be able to follow that, it is a very simple Sanskrit. All of you know Sanskrit here, reasonably well? Who doesn't know Sanskrit? Raise your hand. Can you read Devanāgarī or no? No. Then I think it will be difficult. Now all others know Sanskrit.

The reason is this. Your interest may be in a hundred different ways, I am not questioning those things, you may be some PhD candidate, some people who are interested in stories, some people interested in history, a variety of things. But if you want to enjoy particularly ancient astronomy, the Vedic *upākhyānas*, the stories, you may be only a storyteller, you may not be interested in the astronomy, you will learn some Sanskrit. Without Sanskrit you will not be able to enjoy these things as insiders. You will only be listening to what Pingree and other people who translated and give you, you will be reading that. So please learn some minimum amount of Sanskrit. Maybe some two-semester course or one-semester course something you have to take. Okay that much is sufficient, because even this *Mahāsalila* text you can understand if you know Sanskrit reasonably well. You need not even read my translation, the original itself conveys so much. I have tried to put in a translation, whereas the translation will not give the nuances of the original. And the stories, the dramas of Rohiṇī and Soma remaining only with Rohiṇī, they are all nuanced. They are all like dramas and poetry. Okay that much is sufficient.

We go further, we have the... I said about the introduction, that is the first chapter. What I have done in the first chapter is only to give all the background information which you would need to understand this book as an independent text without even knowing anything about Vedic astronomy or Garga or Parāśara and all of that, all that information I have tried to fill up here.

And the second chapter is mostly about why it is Vedāṅga. What is its connection with Veda? Now to understand this you have to know the Vedic texts and match between the Vedic texts and here what is the overlap. How that can be understood only if you know this, otherwise you can't understand something in the Vedas. And Vedic texts can be taken as *yājñika* and as *ādhidaivata* and *ādhyātma*. This is the *ādhidaivata* interpretation where it comes, all that I have discussed in chapter two. There is no Sanskrit there, it is only English running, you can read it.

Even the astrology which comes up, the Rohiṇī story, that also I have covered in the second chapter. So if you see one... little bit which you can read for yourself, I will quickly go through this. I have given an introduction to *tithi* and *karaṇa*. That is what we will study on page 45. And on page 46 you see I have given the shape of Moon... this is how the text is put up, there is an appendix. All the things which are published I have put up as an appendix, some five of the chapters. Now the text itself starts... but you can read the first and second chapter firstly. You need not go to the third chapter where the translator notes are there, that would be kind of an advanced study you can have. In other words, this book can be taught as a one-semester course, or maybe a two-semester course. Like *Parāśara Tantra* can also be taught as a one-semester course. There of course you need some other extra information, a little bit of astronomy. But here almost nothing is needed. Because this is all directly visible things what they have written. They have not worked out any astronomy here. So this should be understandable by anyone. The only thing is you have to have that perspective what they are telling you have to understand. And the nuance comes only from the Vedas.

So the third chapter, the original needs a lot of notes if you want to go there, but the second chapter doesn't need anything you can directly read. And this *tithi* is in fact I have pointed out, it is same as in English you would say 10, 11, 13, that "th" which is there in the end, which is a limiter. 10th means 10. May be a row, 10th minute, it can be anything, it can be time or space. In fact, in Sanskrit as well as in many, even in English, when you say *purā*, *purā* can be front, *prāk* can also be front, it can also be in time. So same thing even in English also. Sometimes we say front, sometimes before I say, 'he is standing before me', 'he came before I came', it is a time. So these things happen, in Sanskrit also it is similar.

So if you see this word *tithi* which has come up, later on it gives in the inside talking about Pūrṇimā, it is a *pūrṇa tithi* is the word which comes for the first time. In the *Mahāsalila*, in the Sanskrit text let me go further then you can see that sentence. When Moon's face, *āsyam* he says, *āsya* is face or the seat or the sitting place, when it becomes full, that time is what is called *pūrṇa tithi*. *Kālo bhavati* he says, it is the time at that instant. So it is a limit, again *punarāvartate*, it immediately changes and goes back. So the word *tithi* is used as a limiter the first time in this text. So that should sort out some of the problems people have with respect to the Vedic usage of the word *tithi*. And later on in Indian tradition the word coming as *tithi*. In the *Mahābhāṣya* uses that word *tithi*, and I have given references to that also here. So for Sanskrit people there should be a reference for that.

Now that *karaṇa* also I have discussed here. I have given a table on page 51 if you can see. And I have given a detailed discussion, how from *Taittirīya Brāhmaṇa* the 60 names you needed, *prajñānam*, *vijñānam*, and all that, got replaced by only these numbers. This was

sufficient to have 7 *cara karaṇas*, and 4 *sthira karaṇas*, totally only 11 names. Because the names became important. Instead of 60 names you remember, you have only 11 names. 4 are fixed, the remaining 7 they rotate, so finished. So you can understand everything with reference to that. That is again Vṛddha Garga's contribution, first time it comes in VGG. It is in the other JS, but to understand that I have put it here. Because *Mahāsalilam* uses *kiṃstughnam*, *karaṇam* it uses. *Tithi* it comes up only in the *pūrṇa tithi*. So *karaṇa* was the original usage.

Lecture by Prof. R. N. Iyengar (10)

But there are a few other things, almost everything is important. But unless we know the moon and the grahas we can't proceed further. The other things I can skip, the geography and those things.

For the moon, that is the tithi concept. This is how the brightness of the moon changes. That is, this is pūrṇimā you assume. This figure, can you see all of you? And this you assume it is 100%. This will be amāvāsyā where the shine is zero, that means it's totally dark. And this also varies depending on whether it is apogee or perigee. That is the ucca and the nīca.

It doesn't straightaway decrease even though he said each day one kalā is decreasing as per the Purāṇa, it is not exactly right. What happens is initially it is slow. Then it is very fast up to the tenth day. From tenth, that is daśamī. From daśamī to pañcadaśī it will be again slow. In other words, it means if this is pūrṇimā full moon, you go to the next day, that will be Kṛṣṇa pakṣa pratipat or first day, very hard to say whether it is pūrṇimā or it has changed. Similarly, you go previously, that will be the caturdaśī. It will already be looking like a full moon. So the full moon, very hard to make out the changes unless the changes come to the third or the fourth day. In other words, this is a non-linear variation.

Now what these people have done, yesterday I showed you that tithis, five tithis: Nandā, Bhadrā, Riktā, and Pūrṇā. And the same thing is repeated by others, by one of the systems. And the origin of that is here. What he says that five kalās are drunk on the pañcamī. And then another five kalās are taken away on daśamī. The remaining five kalās go away at the third part. Now this is actually a Vedic mantra. That is in the Aitareya Brāhmaṇa, again the Sāmaveda. *Candramasaḥ kṣayavṛddhī bhavataḥ yadā vai candramāḥ kṣīyate ca apyāyate ca nanu vyākhyāsyāmaḥ... pūrva pakṣe devā dīkṣante prathamam pañcakalām pañcamīm bhakṣayanti. Then rudrā dvitīyam pañcakalām daśamīm bhakṣayanti.* So he says Vasu, Rudra, Āditya and these are the three referring devatās or the important forces with reference to which five kalās, five kalās are taken away. Then ṣoḍaśī remains. The 16th part remains. So that is why the moon has 16 parts or 15 parts. And kalā is sometimes called 1/16th. As a measure, kalā is taken as 1/16th.

And you know initially before, a rupee had 16 parts. The ancient rupee had 16 parts. And each part was called an āṇaka. Aṇa in English, āṇaka. That had 12 parts. Each āṇaka had 12 parts. I hope you people know that. We had all in our primary school you know calculations to be done as rupee, aṇas, and pies they would say. Rūpāyī, āṇe, kāsu. So each āṇaka will have another four pies or four kāśu or what you say dammiḍi, dammiḍi in the older things. They are available in that pies and those things in some museums. Anyway, British took the same system when they introduced this. Rupee had to have 16 parts. Because it is the full kind of something like a moon. Anyway.

This is the 16th kalā is remaining he says. This is an important concept why it didn't become zero. Today I would say it is zero, oh everything has been removed. That zero concept had not yet come. Not a limitation. It was the starting point of that. When the concept of zero came up

in India, śūnya, it has come up from this. I have discussed that in the book, I can't go into the details of that.

How did it happen? There are two things which are there. *Pūrṇa tithi paurṇamāsam kālo bhavati.* That you can visually see. That filling up, filling up, then it becomes full. Even though it will be difficult to exactly say. Once it changes you should know it has filled up somewhere. Without fully filling up how can it happen? So that is the instantaneous time of filling up, that is what is called pūrṇa tithi. You read it yourself. It is called the pūrṇa tithi. Pūrṇimā day is different. Because each day is only 30 muhūrtas. The day may be longer, but instant is just like that. You can't hold it. Because it is continuously going. Second, you come to the amāvāsyā, what happens? That also I have given. The important concept of sānnāyya. On the amāvāsyā day Candra is supposed to be—not Candra it should say, in the Purāṇas it would be said like that—Soma comes to earth and stays on the amāvāsyā day. Where? In the herbs, in the grass, in the auṣadhi, in cows, and in the water bodies. That is the lakes and tīrtha kṣetras. And among the āhitāgnis or the brāhmaṇas. That is where Soma will be staying on the amāvāsyā day because he is not visible. What happened was the question.

Then what happened? He is seen in the west in the evening. That is darśa. See generally you look to the east to see moon or sun or whatever. But when first it is seen on the amāvāsyā day it is in the west. That is called darśa. In between what happened? That is sānnāyya. Not the day which is of 30 muhūrtas. And if you go back, before amāvāsyā, what was happening? That is the Kṛṣṇa caturdaśī. Kṛṣṇa caturdaśī you see in the east because every day sunrise has to be seen to count the ahargaṇa. Ahargaṇa they were doing only with reference to the sunrise. You see the sunrise, moon arc is seen. Caturdaśī, Candra is seen before sunrise. Or above sun. That is the māsa śivarātri. Māsa śivarātri happens every māsa right? That is on the caturdaśī, am I right? Caturdaśī, Kṛṣṇa caturdaśī is actually the māsa śivarātri sir. Don't worry about the exact instant as it is given in the pañcāṅga, that is not important. So above sun you see the moon's arc. Crescent.

But then the amāvāsyā starts. Both things vanish, you can't see, some days you don't see moon at all. Sometimes you look to the west, then also he is not seen. That is because of the elliptic nature or the orbit and so many other things. They are later developments. But in between darśa and amāvāsyā what happened was the question. Now in the pūrṇimā it was easy. Because you know you have seen almost the full moon arc and then you know that it is decreasing even though you can't see it, but once again it repeats so something it might have filled up and then it has leaked. The Soma or the rasa or the shining or whatever it is, it has gone. That is the devas have come, taken something. *Paurṇamāsyām abhiśunvanti*, so they have taken something.

But in the amāvāsyā what happens? He was with Sun on the caturdaśī. Because I saw his crescent in the morning. In the east. Now when I keep on watching, watching, watching I turn to my west and I see him. Sun has already gone down, it is dark. Otherwise you can't see moon. Already he has gone down. So you see that, he was with sun. He travelled with sun. And then he has separated from sun. This comes up in the brāhmaṇas that on the 15th day moon enters into sun. Or enters into the mouth of the sun kind of thing. The stories are there. Now the

Indologists have taken this and misinterpreted that they are all imagining stories, it's a primitive story that sun as a crocodile will swallow moon and all kinds of things. They say like that, but this is the principle which is there. And the brāhmaṇa stories are here very clearly said.

Moon was taken, *sānnayati*, he was taken from the amāvāsyā day and then placed there and he became a darśa, he could be seen. These are the phases of Prajāpati himself. You know Prajāpati has four phases? As caturmukha Brahmā is another thing. Brahmā is Prajāpati, Viṣṇu is Prajāpati, everybody is Prajāpati take it in that sense. Darśa pūrṇamāsa, he himself says they are the two phases of Prajāpati. Which are the other two? It is the sāyam and the prātaḥ are the four phases is what he says. Sāyam and prātaḥ when? Every day evening and morning? There are so many evenings and mornings. Between darśa and paurṇamāsa, there or paurṇamāsa to paurṇamāsa if you take, there is one sāyam at sandhyā, and prātaḥ sandhyā and one sāyam sandhyā. So in the prātaḥ sandhyā aṣṭamī you see the phase in the center. And in the other pakṣa you see in the evening. In the Kṛṣṇa pakṣa you see in the morning. Early morning, aṣṭamī. That is one phase. It always turns towards sun. And in the śukla pakṣa you can see in the evening. Again turning towards sun. These are the half phases you can call it. These are the four phases, one to the east, one to the west, one to the south, one to the north. That is the iconography which has come up of the caturmukha. So it is the month connected with moon. Sāyam and prātaḥ is not everyday, you must not take it in that sense. It is the middle. Okay.

Now this is the mantra, the text here at 52 what I showed you correspondence, why it should be taken as vedic. Then about graha. If I finish this then I can go to the other things. The graha I mentioned already a little bit. Now how many grahas are there is the question. It is very clear: *vedoktānām grahāṇām aṣṭaśatam saṅkhyāyate*. There are 108 grahas. What are they? *Tatra ekaśatam ketūnām paṭhyate*. First he said about ketus, 101. *Somārkau pañca tārāgrahāḥ*. So *pañca tārāgrahāḥ* is the standard word. They are the, they look like the star, they are star planets you can call them. They are not stars. They are not nakṣatras. But they look like that, they are tārāgraha. And Soma, Arka, Candra and moon they are the other two. So totally 108. Now 101 which are these ketus? They are the comets. Or some transient objects. Totally it is 108.

Now this has led to quite a bit of controversy and people have asked me what about the navagrahas sir and all that? Do we leave the navagraha pūjā? The navagraha pūjā, ketu is in plural number. People don't know this. *Ketūn praṇamāmyaham* is the one which comes there in the dhyāna śloka. *Tān ketūn praṇamāmyaham*. Somebody uses *tam ketum praṇamāmyaham*, it is his choice, but who is this ketu? It is not the descending node. It is Rāhu is, you may call him the ascending node if you want, later on that tradition has come. But at both the nodes eclipse is possible. If you see from the modern point of view. And in all ancient texts including Rāmāyaṇa, it is Rāhu who causes either solar eclipse or lunar eclipse. Rāhu simply captures Soma and Arka, it is a principle. It is simply a shade, it is a shadow. It is explained here also. Then what about Ketu? Ketu is not in the horoscope you may put like that, that is your choice, you have given a different name for Ketu. It was not at all prevalent before in the pre-BCE period you know. Ketus were always comets. And the visible comets are 26. That comes up in the Parāśara tantra, he gives a list. In the Vṛddhagargīya jyotiṣa here a few of them are mentioned. Mahāsarpa, Romāśa and a few of names are in the Ṛgveda also.

And it is more imagery. That is if you say *vāravantam* in moving a fast moving horse in the sky with a hairy tail, it has to be a dhūmaketu only, what you call today dhūmaketu. And written on that but there is no time for me to cover all those things here. Now this is what I had put up here for the tārāgrahas, the five ones, and he gives all the details, you please go through that. And this is the graph I was explaining here. And then Rāhu comes up. Rāhu comes how? *Atha aparo āgantuḥ mṛtyuputraḥ*. He is called mṛtyuputra. He is āgantu. Āgantu if you see the original meaning, he comes without appointment. Āgantu is actually the atithi, but āgantu is something like unwanted. We do get guests sometimes unwanted. So he comes unwanted sometimes. So how did he come? There is a story, let us not worry about it. *Ṣaṇmāsye parvaṇi yugapad upatiṣṭhati*. *Ṣaṇmāsye parvaṇi* every six months in the parva *yugapad upatiṣṭhati*. Suddenly with the parva he comes. In other words, it is not simply amāvāsyā pūrṇimā. There has to be some parva a joint. That joint is the node. Which became later on the node. And this is connected with the concept of *pūrṇa tithi paurṇamāsam kālo bhavati* and *sānnāyyam*. *Sānnāyyam* is in between darśa and amāvāsyā. Now mathematicians may understand this far better you have a line which is negative and it goes to the positive region. It has to cross zero. You can call it the Rolle's theorem or Mean value theorem or whatever name you may give. But the concept is that, that is why sānnāyya is there.

And that sānnāyya in the yājñika thing they do that. Because the rāja yakṣmā has to be cured. If the yajamāna had the rāja yakṣmā that is consumption, what is called tuberculosis today, not exactly consumption. Āyurvedic people may have different kinds of yakṣmās and all that. I will not go into those details, but sānnāyya has to be offered. Because moon, Candra had got yakṣmā. And from sānnāyya gods removed his yakṣmā. And that happens with saptadaśa āhuti. Not the ṣoḍaśa but *saptadaśa kalām nirvāpayate*. That comes up there. In other words, 15 kalās are already gone. 16th is remaining is what initially they said. Because they could not start with zero. Always the counting was from one. But cosmically what happened was the question. That is sānnāyya. How did the gods do? *Saptadaśa kalām nirvāpayati. Prajāpati saptadaśa kalām nirvāpayati.* Nirvāpayati is what? He removes, is actually he shaves off the saptadaśa kalā. Vāpanam, nirvāpaṇam is that. And what do the yājñikas do? They do sānnāyya. They mix milk and curds. That is called sānnāyya. And they offer sānnāyya on the darśa day. Because sānnāyya has already happened for moon, because they are seeing darśa, so they have to remember that and offer that. Then the yakṣmā is gone. This is a drama, a simulation as I would call it in modern ways. Of what is done by the gods, what is happening in the sky, there is a replica of that to remember, or maybe just for fun, or just because I want to identify myself with the universe.

In fact many of the mantras are like that. In yajña they say I am a god, I am Sūrya, I am this, I am Soma, so I am doing this. So they are trying to do an identification. No one mistake this for the later Vedānta. Now I know that the ādhyātma people would say starting from *Agnīmīle purohitam* everything is only this Vedānta, Vedānta, only Brahman. Absolutely not correct. You may, after studying the Upaniṣads and all of that you may go back and say it looks like this. But what about this? And what about the yājñika people they come and do all of this āhutis... Are they identifying themselves as human beings? No. It is a kind of simulation they were at least in the early times they were doing. What purpose? It becomes social, anthropological, and

group thinking. That somebody has to research and do investigation. It is not part of this. It is something far serious than all of this. Why they did? The season identification yesterday I said. They looked at people and said your eyes are red so it may be this kind of thing. So how this develops? I will leave you, leave it at that.

Then every six months it is possible that you can get a eclipse. But not exactly every six months. Possibility is there. Because *parvaṇi yugapad upatiṣṭhati*. That is Rāhu. When Rāhu along with the parva comes it is eclipse. But parva is already there, otherwise only one may be there. And Rāhu is after all *śarīram akṛtvā ciro varṇān vidarśayan bahubhir varṇa samsthānaiḥ grahaṇam mokṣābhyām devasati prajāḥ*. He himsati only. Rāhu. And where he can do either for sun or for moon. And it is only *śarīram akṛtvā* he doesn't have any, it is only by the shadow he, identical. Okay. And this comes up later on the Rāhucāra which we have not yet edited. It is the sixth aṅga or so. And that not fourth aṅga I think. That is yet to be edited where all these periods are given. Six monthly period, three and a half year period, several periods are there. That is yet to be investigated.

Then what about Ketu? There is a full chapter in the Vṛddhagargīya jyotiṣa called Ketumālā. One paper we have published in the Tirupati journal Mahasvinī. If you are interested you can see that. A student's part PhD was on that. Sudarśana was here a few days back you know. So you can see that. Full 101 names are given of the comets which are there. And as, as I said about Parāśara there also 26 comets are visible. And this is actually dhūmaketu. Because the question is there. *Katham vā ime dhūmaketavaḥ prādurbhūtāḥ kativā taisaṅkhyāḥ*. Always he wants to count. *Kiñcaiṣām varṇasaṅkhyānam*. What is their color? *Śikhāparimāṇam*. What is the length of the thing, the tuft. That is the length of this, you know. This śikhā. They have a tuft, śikhā. That is what he gives, approximate estimation, maybe about 30 degrees or 20 degrees or something of that kind. And I will not read this full... How do they come up is the question. Then there is a difference of opinion between Garga and Bādhuri. Bādhuri says *tatranihitam ete pi vā merum paryāgacchanti. Sūryaraśmin vahamānāḥ sūryamuktāḥ dṛśyante*. They also go around sun and only when they are separated from sun you can see, not otherwise. So this is his argument. And what Garga says is *nakṣatrāṇi upasṛjanti. Etehi udaryasthāna dhūpanasamspṛśaiḥ nakṣatrāṇi upasṛjanti*. Occult the stars. Because saptarṣi was occulted. Śiśumāra was occulted. And in the Kauśika sūtra it is very clear you have to do a special homa for that. For that because the saptarṣis were captured by the Ketu. *Sarva eva nairṛte sūryasya abhitaḥ carāḥ*. That is what Garga says. They can always be seen generally in the southwest direction of sun. That is in the evening. Southwest when the setting also. Even today that is true. In the west. *Na ca eṣām udayāstamanadarśanāni iti āhā Gargaḥ*. There is no set, there is no rise for them. Because he was using the sun's testing for the Aitareya brāhmaṇa. There is no *nimrocatīti*, there is no *udayeti* for sun. The same thing for them also. So these are the difference of opinion which is listed here, which is a very real kind of thing.

Then Dhruva, Meru is there for measurement. And then the Rohiṇī Soma legend comes up. And somebody yesterday asked about dimensions of planets. Yes, there is some viṣkambha which is given. There is a list there. You can study them yourself. It is there, I have translated anyway. But I have not done any comparison or whatever. The size of the planets, including

size of stars are there. Svāti, the bright stars. How many yojana. Very small numbers are given. But they seem to be something like a diameter. But I haven't, you can't estimate, I am sure of that. But should be something relative. Now on this well, even Purāṇas and Sūrya Siddhānta gives some dimensions. The diameter of the planets and stars. That's a very ancient tradition which is coming here. So Sūrya Siddhānta has very ancient information. That is quite clear, everybody agrees with that, but what that information is the question. Why I am mentioning this, yesterday I showed one book of Thompson of the cosmography of the Bhāgavata Purāṇa. He discusses this. He was an astrophysicist from MIT. Passed away very young, 45 or 50 he passed away. A very brilliant person. He has looked into the Bhāgavata. I wish he had looked into other texts also. Anyway you read that book. And he has written on Sūrya Siddhānta also. What that diameter may mean. Directly diameters don't mean anything like I showed the raśmi and all of that. It is the relative thing which matters. If the ratio, sun's brightness to the brightness of Śukra, 1000 raśmi to 16 raśmi logarithmically how did it change, they are still visible. And that ratio is the scientific thing. Because the absolute numbers are different. Can have 1000 you can have 100, you can have 30. Like 24 hours today, 30 muhūrtas in the previous times. It is the ratio which matters. And the ratios are the meanings in many of these things. In the first talk itself I was mentioning about rūpasamṛddhi, what is meaning, how do you get this meaning in the yājñika and all of this. The meaning is generally when it comes to measure it is a ratio. Like somebody is tall, somebody is short, maybe 1/4, 1/3, something of that. Okay.

So keep this in mind, then you will be able to understand the other things. Now this Rohiṇī, Soma Rohiṇī legend. Because there is one person who doesn't follow Sanskrit. I will have to show this in the second chapter... 2.6 onwards it is there. That is page 60 onwards. *Amāva ... patni...* Can you are able to locate it? Page 60. Stars become nakṣatra. Then comes natal astrology in 2.7. That drama is in 89 to 1991, 92. That MS is the paragraph number. Which you have translated to some extent, 64, 65 page number. That you have to read it. Okay I will tell the story you can read it later on. Now if you see... now Candra that is Soma, he has this cycle of increasing, decreasing, increasing, decreasing. Relative to Candra, nakṣatras have no decreasing. So *nakṣatrasya nakṣatratvam* he says. Candra changes. But nakṣatras don't change, that is why they got the name nakṣatra. And the combination of this, one which is fixed, one which is changing, indicates karmaṇya. Indicates, gives a signal. How very interesting it is if everything is fixed you don't get anything you know. But if something is changing you get an information. Something, something is happening, something is changing kind of thing. That is the starting of astrology actually. But how does he introduce that? That is the story.

He says Dakṣa Prajāpati had 27 or 28, some people say 28. *Kecit vadanti* he says. *Kecana vadanti aṣṭāviṃśatiḥ iti*. That means originally they had counted 28 unequal nakṣatras or whatever, in some time, some time you keep it what the time also we can determine. And then when this was happening, they understood this pūrṇa tithi and this sānnāyya and all these things were done. That is an intellectual development of some particular group of people who did all of this. They tried to combine the cosmic, *saptadaśa kalām nirvāpayeti* and then the sānnāyya and bringing up and then the darśa. Should there be 27 or 28 would have been the question they would have thought. And the question was what are nakṣatras? What is the meaning behind Candra and nakṣatra? If Candra is some kind of a kāla, grahas are kāla and their previous

people the ṛṣis, maybe for 1000 years they had already done all of this Ketu, *aṣṭottaraśatam saṅkhyāyate* and all of that. In today's Veda we don't have aṣṭottaraśata graha. But in the practice, in the yājñika thing, you have more than 25 grahas, that is the cups. And if you accept these cups represent some other thing. Could have been large also. And new concepts have come up, so you have to be careful with this. But astronomically the story is that.

He had 27, some say 28 daughters. He offered them to Soma to follow dharma. You see how the civilian or the civic sense gets combined with this. Don't ask 'were not people getting married before all these things?' It is not like that. Maybe they would have thought of a theory and brought out a theory for this. He offered them to Soma to follow dharma. That is very clear. Because dharma has to be followed only with a wife. Otherwise that cannot be followed was the original Vaidika concept. Soma agreed. Who is Soma don't question right now. Sun, Soma. Because this Soma Prajāpati, Soma Rohiṇī and Somapatni, there is a mantra also of that kind. You have to be a little bit careful, just listen to me on that. Soma agreed but he stayed only with Rohiṇī. There is a Sanskrit text is there you can read for yourself.

The other daughters, the other 27 or 26 I don't know, they complained. They went to whom? They went to Prajāpati, their father and complained that you know he is not staying at all, he is not treating us equally. He is not staying he says. If you read the Sanskrit it becomes clear, anyway I cannot perhaps do that. '*rohiṇyām abravat*' and then the sisters say '*bhaginyaḥ abhicāram mā vartasva*'. They tell Rohiṇī 'don't do abhicāra is not anything special, against the accepted civil notion or the manner, don't do like that. He should be going equally. He should treat everyone equally.' That's what he says. Then once again they go and complain. And again calls Soma and he says 'Prajāpati says see you are not behaving properly, you are not moving with them equally, I hear that.' He says 'no I am moving with them properly. I am treating all of them equally.' That word 'equally' is the key. He doesn't say exactly equally. And later on the word comes '*samam vartasva*'. Even in the mantra it itself is there in the Vedic Brāhmaṇas. He was moving, no problem. But he was not equally moving. You follow the nuance of that. And then Prajāpati says 'you will have yakṣmā, you will have rāja yakṣmā.' He curses him. Suddenly Candra, till that time was Soma, the drama was with Soma. Suddenly Candra answers. 'don't do that, I am going to be equally with them' because how? '*ṛkṣāṇi nakṣatram bhavati iti avagacchan*'. He understood that the ṛkṣas become nakṣatra henceforth. So Rohiṇī became not single, one patnī, one star. Became five stars. So she became a nakṣatra. So all the ṛkṣas became nakṣatras. I hope you get the idea.

And that is the most important statement. He understood '*ṛkṣāṇi nakṣatram bhavati*'. *Ṛkṣāṇi* is in plural, *nakṣatram* is ekavacana. Don't worry about the grammar. Because the transformation has to happen. That is what happened. So how many ṛkṣas are there? Stars are there? 86. Vṛddhagarga lists them. That I have given in the appendix also, *eka tāre, dvi tāre, ṣaṭ tāre* and all of that. Each nakṣatra. And once this happened, so equal movement. That means the nakṣatra division was equal. I hope you get the feeling now. So the division of the nakṣatras into equal sectors is what it means. So now Candra will be there in each of the nakṣatra. Now what is the advantage? Now what are the daivata? *Daivata prayojanam kim*? This is the next question. Now that again there is very beautiful he said. So if this is what, what is the page 60 'stars

become nakṣatras'. So don't treat them as same paryāya pada, they are not. And I have given the table yesterday of the Atharvaveda parisiṣṭha, Rohiṇī being single, whereas in all other texts it becomes five. So there was a transition time. That time you can take it as 1800 BC. Because that is the Maghādyam period. So there already the sectors were divided equally. 1/4th, 3/4th and all that. So this should have happened roughly in the same period, maybe 100 years before or 100 years later.

[Question from Audience]: Sir just a followup question. On this one when where they describe darśa and pūrṇamāsa of the moon... I can't hear you, use your mic. The mic is there. Now it's okay. Hello. Yeah. So in a follow-up question on this one, where they describe darśa and pūrṇamāsa of the moon, now for the inner planets as well there is a gibbous state. For the inner planets? The gibbous state is there for the inner planets as well. Is there any mention of the gibbous state, the same kind of a moon's phase changing? Phase changes. Phase changes. The same way for the inner planets, that is Mercury and Venus.

[Speaker]: No no, I am forgetting your question. Phase change is not mentioned here in the Mahāsamhitā. But in the some of the Purāṇas there are some descriptions which most probably refers to phase changes. Can't discuss it today. That has to be some research is needed on that. That is what I say, Purāṇic astronomy nobody has studied. Including the Vedaśāstric astronomy. And there is also the graha descriptions. And what they do is describe the sky because the concept is 'as it is here, so it is there'. That means what is not here is nowhere else in the Vedāntic text. But that started from this. Yesterday I mentioned about *deva gṛhā vai nakṣatrāṇi* and a few other things you know. So the stars, the planets and some of that are like some king here and his subordinates and his citizens who are all there. And the citizens are all getting some strength from the king in the north, in the south. You understand what I mean. There is a kind of a rāṣṭra, not only on the ground but rāṣṭra also on the top. That is why this svarāṭ, virāṭ and those things come up, sāmrāṭ. It is both in the here also you can have emperors, there also you can have that kind of thing. So Dhruva was the cakravartī. So Dhruva was moved, I didn't go through that, because Dhruva was removed from the cakravartī ship. I have given it in my notes. In Maitrāyaṇī samhitā it comes, through an abhicāra a king can be removed from his place because Dhruva himself was removed. He was the cakravartī. And that abhicāra is shifting, turning that Dhruva graha which I mentioned the Dhruva graha just a few minutes back. That Dhruva graha in the north the priest has to turn it assuming in the opposite way that let this person whoever he is thinking let him be *paryācīkīrṣan* let him be removed. He becomes *cyavate*. He is the acyuta he becomes *cyāvyate*. He is shifted. So they did this kind of thing to remove people from power. So and these phases and these things in the sky the Purāṇas they get their power from sun. The suṣumnā ray, then the arvāvasu, parāvasu, vibhāvasu these are the names of the rays in the south, southwest. They get some power out of that. It is a very complex kind of thing. That means from there the earth came and in the earth they made all the kingdoms, these human beings and all that. They tried to put this theory onto the sky to understand them you know. So we will go further. Okay I hope you have understood this.

But this doesn't explain totally the legend. Now why was that Rohiṇī so important? Now in the Purāṇas if you see, the śāpa is given and it becomes simply Kṛṣṇa pakṣa. He keeps on

decreasing. Even in the Vṛddhagargīya jyotiṣa in the later things it simply says rāja yakṣmā so tithi is decreasing of the shine is what is said. Maybe counting of the tithi started from that time. That's what it means. What time? When Rohiṇī was removed as a single star to become a five star. Why did they do that? Now if you see the equal division and the dating that we had given that is the 3/4th, 1/4th Viśākhā and Maghādyam and Śraviṣṭhārdham approximately it would have happened at that time. But before that what happened? Before that Rohiṇī would have been the most important star. Single all right. But most important. What for? Samvatsara prajāpati he says I will be telling. And Rohiṇī is the prajāpati patnī because prajāpati stayed with Rohiṇī. Right, that is the legend. They later on said Candra stayed with Rohiṇī because it is for cinematic purposes you can do all of that. He escaped, he went away with that and there are temples also. That's in Tamil Nadu there is some kovil is there I have forgotten. Tingaḷūr or somewhere where you know Rohiṇī there is another vigraha which is kept as the wife of Candra and all that. Fine, perfectly fine. Culture develops like that, art develops like that. I have no objection. But the cosmic thing is here and what was that? That I have quoted, but it takes too much time. That comes up in the Kaṭha samhitā. What is prajāpati rūpa he says, asks. And prajāpati rūpa is when Rohiṇī rises in the vasanta ṛtu. When people are all happy and all that. Rohiṇī is something wonderful because people would be happy when Rohiṇī rises. So beautiful and explains how radiant was Rohiṇī and all that. And if you identify that prajāpati is samvatsara that is the year beginning. And samvatsara patnī is going to be Rohiṇī at that time. Now this word samvatsara patnī comes in other places also. *Pūrvaphalgunī samvatsarasya prathamā rātriḥ, samvatsara patnī* the word comes there. So that concept was there, that is a mithuna, that is something which is a dyad, you want an informal kind of word. So dual or dual dyad. There are two things which always go together. And if samvatsara prajāpati and prajāpati stayed with Rohiṇī, if you read that mantra and at that time the new odana is given. Food is given to the children. Even today in the Rohiṇī nakṣatra you do annaprāśana. Annaprāśana the best nakṣatra astrologers may be knowing is the Rohiṇī. Because the Rohiṇī is something which rises and that is the *prajāpateḥ rūpam*. Like yesterday I showed one *nakṣatrīya prajāpati rūpam*. This is the Rohiṇī *samvatsara prajāpati rūpam*. So in the vasanta ṛtu when Rohiṇī rises, it is not an exact situation of equinox because equinox is in the center of vasanta ṛtu. So Rohiṇī as an equinox around 3000 BC as a star, as a nakṣatra it will be precisely zero. But they they don't mention that because the concept of zero, concept of longitude, equinox they were not there. In the vasanta ṛtu it rises, maybe plus or minus a week or whatever you know. And continuously that is what was taken as the year beginning. But due to precession it changed. They could not put Rohiṇī in that ṛtu. Very clearly Rohiṇī was not there. That means prajāpati had left her. But Candra was there. So they wanted a new way. It is an intellectual development. Combined with observation and what I can say a soteriological thinking. Extraordinary kind of thing. And they made it equal. And at that time equinox, vasanta ṛtu was not in Rohiṇī at all. It had moved to Kṛttikā. Kṛttikā 1/4th and Viśākhā 3/4th are the equinoctial points. So when sun was in Kṛttikā 1/4th was the vasanta ṛtu. That is the spring equinox. 1800 BC. This was before that. You I hope you get the point. And this if you see, all things become simple. And from then onwards he started moving equally. Now the next question comes. How did astrology start from there? And that is very interesting. And this partiality is now removed from Rohiṇī. Okay. That much you understand. And Rohiṇī is important, it is not simply the purāṇic story that in Kṛṣṇa

pakṣa is the rāja yakṣmā no. It is Rohiṇī is the key figure there. And of course some people would say Jyeṣṭhā is opposite Rohiṇī that is also important. It could have happened, I don't deny that. And that was the time when Abhijit was also removed. Because you want to make things equal, you don't need Abhijit you know. Because the distance between Uttarāṣāḍhā and Śravaṇā where Abhijit comes is very small. They said when you make it equal why do you need it. And that equality was there in the sky, as well as for me in the rising days. 13 5/9 days. I don't calculate that. So 13 5/9 days the equal spaces are there. So it is the *kālakṣetrayoḥ sāmyam*. That is the principle which continues throughout.

Now the astrology legend it is in page 64 onwards. Dakṣa and all the Soma agrees... okay yeah it is MS 91 it comes up. That Dakṣa asks Soma to behave in the same way, *samam vartitavyam*. With the 27 nakṣatras. So that the activities such as fierce, quick, fixed... if you read in Sanskrit it makes better sense. So you can do that. The actions have to be... this is the mantra given in the Kaṭha samhitā... *yad odanam prāśnāti, etad vai sarvam avarudhya tad asmin ekadā dadāti rohiṇyām*. So in the Vedas, Maghā is always plural, Śraviṣṭhā is always plural, Rohiṇī is always ekavacana. And Viśākhā is always dvivacana. Kṛttikā is sometimes as a group ekavacana, sometimes Kṛttikāḥ is plural. Please remember this. This mantra is this he says... *Rohiṇī tasmād yad udeti sūrye kriyata etat vai prajāpateḥ rūpam. Yad kheṣu udeti sarvāye ete prajāḥ pratinandanti. Didṛkṣaṇyoḥ darśanīyo bhavati.* So this whole thing is the one which represents a prajāpati staying with Rohiṇī. And that is when the odana, that is the annaprāśana had to be done. The first annaprāśana was being done.

Now the next. Oh this I think... in your book you can see the 91. What he says is he wants Prajāpati to move with everyone equally, it also does. And for the equal movement, what is the phala he says, you are going to indicate the actions to be done. What are the actions? He divides the actions into six. Fierce action, quick action, fixed, harsh, soft, moving and ordinary. The activities themselves, karma of the human beings is divided into six things. You know remember the karma guṇāṅga which I yesterday mentioned. So the nakṣatra karma but the karma itself was six kinds. And further depending on the devatā you can have more number of divisions that is a long table. For each nakṣatra there may be some 10 kinds of activities. So 27 into 10 some 270 kind of activities. Of course all other activities can be brought under something like 270 or something. It is like the professions. How many professions are there? Kind of thing. And again the birth in that nakṣatra, how many properties can be there for a person? He can be a strong man, he can be a tall man, he can be a beautiful person. He can be a king, he may be a scholar kind of thing. These properties are also coming up. And this is what Prajāpati asks. You indicate, being with the nakṣatras, long time back with one activity. That activity is the property of that devatā. And that is only a name.

In other words, it is all Soma. When Soma is in Kṛttikā it is called Agni. But what, sir today also I call Agni, Agni daivata is Kṛttikā. Today I am using. Here it is not that. It is much long before. Before this equal division, before the Rohiṇī legend came, and Prajāpati, Soma agreed that he will not stay only with Rohiṇī, he will treat all the other 27 wives equally. Then this concept of devatā came. But that devatā action was one action. So when did Agni happen in Kṛttikā? Not in 1800 BC, maybe 3000 BC or 4000 BC. When did Prajāpati stay in Rohiṇī as

sthira? Because he is a Prajāpati daivatyam. The devatā is Prajāpati. Even in the nakṣatreṣṭi it is Prajāpati. That is the, you can say, 2000 BC or 3000 BC. Not 1800 BC. Because in 1800 BC *ṛkṣāṇi nakṣatram bhavati. Samāvartasva. Astu*, he agreed. Then the devatā properties, all he preached, became he got that upadeśa, that he will indicate the karmas. Ugra, tīkṣṇa and all these things. Then more divisions come up. That is further analysis, analysis it happens.

Lecture by Prof. R. N. Iyengar (11)

The Anomalous Nakṣatras: Time and Space Exceptions

These timings, measuring half a *muhūrta* here or 1/4th of a *muhūrta* there, can be measured using different methods. You could ask a carpenter to build an instrument. But how do you calibrate it? Calibration had to be done using natural references.

(Plays a short audio/video clip of a Vedic chant)

You hear this chanting—"Mahākānte pakṣasyānte paryākāśe deśe svāsti kāntam..."—this is the *Aśvinī śastra*. This chant takes about 23.7 minutes at a medium chanting speed. So, this is how they defined a *ghaṭikā*! It's a very beautiful dual-purpose system. The qualities are asking a wife, who was sleeping outside in the open on a Pūrṇimā (full moon) night, to go inside and sleep on her bed. "Because today is Pūrṇimā, the moon will come and catch you thinking your face is also the full moon!" I hope she went inside! But beyond the poetry, this exact chant is used for time measurement. It is a *līlā kālamāna* (playful time measurement).

We distributed this *śloka* to about 30 people and timed their chanting. The average came out to about 23.94 minutes, with an error of less than a percent. So, this chant could have been used to calibrate the water clocks (*ghaṭikās*). You don't need to wait for a full day or a full 60 *ghaṭikās* to see if your bowl sinks properly. Have some children nearby chant this standard verse 60 times. If the bowl sinks exactly when they finish, your clock is calibrated. This is what we call calibration in modern terminology, because all physical instruments require it.

There is another text called *Ghaṭikā Yantra Ghaṭanāvidhi*, meant specifically for the *purohitas* (priests). In ancient times, marriages required the establishment of a *ghaṭikā yantra*, followed by a *ghaṭikā pūjā*. The *purohita* would bring the *ghaṭikā*, set it up in the morning, and wait for the specific *muhūrta*. When that time arrived, there was a *ghaṭikā* and a *vighaṭikā* (sub-unit).

To measure the *vighaṭikā* (since the main *ghaṭikā* is over), the *purohita* would chant specific *ślokas* like "*Mārtāṇḍas tārānāthaḥ kṣoṇīsūnuḥ...*" three or four times. Each recitation marked one *vighaṭikā*. "Okay, ten *vighaṭikās* are over, now you can start the *śubha maṅgala sāvadhāna*." That is how it was done. It was the *purohita*'s (or the bridegroom's) responsibility to measure the time. Today, the father-in-law simply gives the bridegroom a wristwatch! It serves the same social function.

The Mathematics of the Chanting Clocks

This chanting-based time measurement came directly from the oral tradition of the Vedas, such as the *Bṛhatī sahasra* and the *Prātar anuvāka* of the *Ṛgveda* acting as a chronograph. The fundamental issue is: how did they measure the movement of the moon in the night? They chanted. Even today, during eclipses, people are supposed to stay awake and chant *japa* (mantras). Why? Because originally, they were measuring the duration of the eclipse!

So, what is the speed of this chanting? It depends on the number of syllables (*akṣaras*). Do not confuse this with *guru*, *laghu*, or *mātrā* (heavy and light metric weights); that will confuse you entirely. Do not worry about *Vṛttaratnākara* yet. These are Vedic *akṣaras*.

How do you determine the syllables? There are *pluta*, *dīrgha*, and all of these variations. The only standard reference we have is the *Anukramaṇī*. The *Anukramaṇī* specifies exactly how many *akṣaras* are in each hymn. If you count three more or four more, it is your error. There may be a *dīrgha* (long vowel) or a *pluta* (prolonged vowel), but it might only be counted as four *akṣaras*, whereas you might perceive it as two syllables. You have to be very careful.

The *Ṛkprātiśākhya* clearly states that there are three speeds for chanting the Vedas:

- **Druta** (Fast)
- **Vilambita** (Slow)
- **Madhyama** (Medium)

An ancient commentator named Uvaṭa clarified that *eka-svarya* (single vowel durations) are used. You do not use the three *svaras* (tones) in the ritual chanting here. It is a standardized practice. In the *madhyamā vṛtti* (medium speed), which is neither fast nor slow, we have an average speed. I estimate it to be exactly what we measured.

Reconstructing the Cosmic Speeds

We became highly curious: what did the Vedic people all over India actually do? So we undertook some hard Indian Knowledge Systems (IKS) work. We collected *Ṛgvedic* audio records from both Kashi (Varanasi) in North India and Mysore in South India to ensure representation.

We mapped the time taken against the number of *akṣaras* chanted for specific *sūktas* (hymns). We plotted them on a graph. The X-axis is the number of *akṣaras*, and the Y-axis is the time taken.

The average speed comes out to be **3,650 akṣaras per ghaṭikā**. For a *muhūrta* (two *ghaṭikās*), it will be exactly double that: **7,300 akṣaras**. This is a perfectly linear scale. As the hymns get longer, the time taken increases linearly, just like a measuring tape. You cannot say, "For a longer one, I will measure differently." That linear line is the ultimate proof of a measuring scale.

This was known to the entire country. The Siddhāntic astronomers of the post-Vedic period achieved a tremendous development in intellectual activity around 500 BCE to 500 CE. Texts like the *Pañcasiddhāntikā*, the *Sūryasiddhānta* by Varāhamihira, and the works of Āryabhaṭa define the astronomy of this era.

What is their definition of time? The *Siddhāntaśiromaṇi* and similar texts state:

3,600 gurvākṣaras per ghaṭikā at a medium speed.

In the faster speed, it is 7,200 *akṣaras*. It perfectly matches our empirical findings! As you go to faster and faster speeds (the longer texts), the graph line stays linear. The *gurvākṣaras* (heavy syllables) equate to double the time of standard *akṣaras*.

This chanting metric is precisely the same principle seen in classical music.

Final Thoughts on the *Soma Yāga* and the 30 Cups

Finally, what did they actually do during the night? Did they just sit and look at the moon?

There is the famous story of Indra crossing the night with the help of the *chandas* (meters). He drank 30 cups of Soma continuously. This represents the 30 *ahorātras* (days) of the month.

Then there is the *Atirātra Soma Yāga*. *Atirātra* literally means "crossing the night." In this ritual, the *purohitas* must stay awake the entire night. But they do not just sit there; they chant the *Aśvin śastra* (the hymn to the Aśvins).

- The chant must start exactly at midnight.
- It must conclude exactly before the birds begin to chirp in the morning (about 5 hours later).
- If you divide the 36,000 syllables of the *Bṛhatī sahasra* by the chanting rate, it gives you exactly the duration of the night!

Therefore, chanting the *Aśvin śastra* during the *Atirātra* was not just a religious ritual. It was the ancient Indian method of precisely measuring the length of the night.

Introduction: Folk Wisdom vs. Systematic Monsoon Science

By Dr. Hariharan

(A.R. Rahman background music plays briefly)

A very good afternoon to everyone. We are going to talk about rainfall in ancient India.

I want to start with a question: How many of you have heard your grandparents, or an elderly relative, say that because the ants are carrying their eggs, or perhaps because the salt is getting wet, it is going to rain? How many? Oh, yes, I see many hands. You see it in action.

Most of us treat this as charming folk wisdom. And while it is charming, it is also sometimes right. What we are going to see today is that these observations are not random. They originate from a highly systematic program of monsoon science that is at least 3,000 years old. It was not just about watching ants. They actively measured rainfall, possessed standardized instruments for measurement, and utilized a 27-value forecast table for seasonal rainfall predictions. When a modern engineer tested their ancient numbers against a hundred years of actual IMD (Indian Meteorological Department) data, the statistics supported much of it.

That is what we are going to explore today: theory, observation, measurement, and validation.

Primary Textual Sources

These are the main sources for our discussion today:

- **Mahāsalilam:** Our oldest source. It is the 24th *aṅga* of the *Vṛddhagargīya Jyotiṣa*. It is structured as a dialogue between Viśvāmitra asking questions and Vṛddhagarga providing answers, written in the Brāhmaṇa style. The summer solstice marker in the text places it in the Maghādi era, roughly between 1800 to 1600 BCE.
- **Parāśara Tantra:** Dating roughly between 1350 to 1130 BCE.
- **Arthaśāstra:** This text from the Mauryan period explains how the state was actually collecting and recording rainfall data.
- **Modern Validation:** Professor R.N. Iyengar, in two of his *Current Science* papers, is perhaps the first person to rigorously test these ancient numbers against modern statistical records.

The Civilization-Level Impact of the Monsoon

Seventy-five percent of India's annual water arrives in just four months—between June and September. If those four months fail, everything fails: the crops, the economy, the king's treasury, and people's lives.

The *Mahābhārata* records 12-year droughts in three or four different places. There is also the famous Bhadrabāhu migration in the Jain tradition. A 4th-century BCE monk predicted a 12-year famine in North India, which led to the migration of thousands of followers—including Emperor Candragupta Maurya—to Śravaṇabeḷagoḷa in Karnataka.

The *Parāśara Tantra* even states that if the sun turns a peacock-blue color, you should expect a 12-year drought. These four months were so central to survival that marriages were explicitly banned during the monsoon. Viṣṇu was said to be asleep. A monsoon failure was not just bad weather; it was an emergency for the civilization itself.

Ancient Cloud Physics and Convection Models

What is the founding question of this science? We see it as early as the *Nāsadīya Sūkta* (Ṛgveda 10.129):

Nāsad āsīn no sad āsīt tadānīm...

...ambhaḥ kim āsīd gahanaṃ gabhīram

Later, the student Kauśika asks his teacher: "*Katham asmāt prādurbhāvaḥ?*"—How does the sun produce cold, heat, rain, cloud, and wind? Notice that rain is right there in the founding question. Rainfall was central to their entire program of astronomy.

Let's look at the older text, the *Mahāsalilam*. It explicitly describes the physics of cloud formation. The text explains that hot air rises from the earth, and then a lateral wind hits it sideways and shears it. The rising column gets flattened, condensed, and hardened, resulting in a cloud. This is a direct description of cumulonimbus formation driven by thermal convection and disrupted by wind shear!

A second theory, attributed to Kṛṣṇātreya, states that water vapor from the ground and mountains is lifted by the wind, gets energized by solar radiation, and coalesces. The only modern meteorological concept left out is condensation nuclei. A pre-instrumental society naturally learned to read other indicators: they used salt, observed ants, and monitored copper vessels.

Standardized Rain Measurement: The Droṇa

This is the crown jewel of ancient Indian meteorology. Parāśara defines a standardized rain gauge: a cylindrical vessel, 20 *aṅgulas* in diameter and 8 *aṅgulas* tall.

- When this vessel fills up completely, it equals 1 **Āḍhaka**.
- 4 Āḍhakas make 1 **Droṇa**.
- One Droṇa converts to roughly **6.4 cm** of rainfall.

This is the exact same principle as a modern rain gauge. Kauṭilya's *Arthaśāstra* reports actual numbers using this system: **23 Droṇas** for the Avanti region, and **16 Droṇas** for the forest districts. He was recording regional rainfall data as a strict state administrative function. Measurement was mandatory, and specific ministers were named to oversee it.

Statistical Modeling and the ENSO Correlation

Parāśara established a rule: observe which *nakṣatra* the moon is in when the first rain of the season arrives. The 27 *nakṣatras* were grouped by their predicted rainfall values. A forecast of

4 Droṇas indicated a severe drought, while bumper years were forecasted at 25 Droṇas (roughly 160 cm).

Because the mean and standard deviation σ are not always efficient at reflecting extreme values in a dataset, it is expedient to represent time-series data in a standard standardized form to visualize fluctuations about the mean value:

$$y = \frac{r - \mu}{\sigma}$$

When modern statistical analysis is applied to Varāhamihira's 27-nakṣatra model, the coefficient of variation comes out to about **37%**. When you simulate a 100-year series using this ancient data, it perfectly confirms that their model correctly captured the core statistical behavior of Indian monsoon rainfall.

The dominant driver of year-to-year monsoon variability is the El Niño-Southern Oscillation (ENSO), a natural cycle in the Pacific Ocean. The dominant ENSO period is about 3 years. Interestingly, the synodic visibility cycle of Venus (*Śukra*) also alternates roughly every 3 years. Venus does not *control* the rainfall, but the astronomical clock and the climate clock happen to tick at almost the exact same rate. Thus, they used Venus as a reliable observational proxy. The ancient 37% variability sits right in the middle of modern meteorological data.

Summary: What They Got Right

1. The Sun drives the entire system.
2. The Southwest wind carries the moisture.
3. Rain falls heavily at convergence zones.
4. Pre-monsoon atmospheric conditions are critical indicators.
5. The natural variability is about 35–40%.
6. Multi-year cyclic droughts occur and can be modeled.

All of this ancient wisdom has been confirmed by modern science.

Conclusion: What They Got Right vs. What Remains a Metaphor

Speaker: So, what did they get right? Pretty much the big picture. They understood that the Sun drives the entire system, that the Southwest wind carries the rain, and that rain falls heavily at convergence zones. They recognized that pre-monsoon conditions are crucial indicators. They accurately grasped that the natural variability of the rainfall is about **35% to 40%** from year to year. They also knew there are multi-year cyclic droughts. All of this checks out; all of it is confirmed by modern science.

What remains a metaphor? There are so many portents and omens told in these texts—predicting what will happen to the king or what will happen to the people. Those are very noisy; we don't know whether they work or not, and they cannot be scientifically verified. We also

saw names like Indra, Sūrya, Parjanya, and Māruta. These are divine name labels, but fundamentally, they serve as labels for physical forces.

The Chain of Transmission

Speaker: Then we look at the chain of transmission. It starts with Vṛddhagarga, who provides the underlying physics. Parāśara builds the measurement system. Kauṭilya makes it an operational, administrative function of the state. Utpala preserves this knowledge in his commentaries. Finally, R.N. Iyengar tested these ancient numbers in 2004 and 2009. So, across 4,000 years, the numbers still hold.

Q&A Session

Audience Member: Can you just go one slide back? Regarding the interannual variability... do the oscillation periods remain the same?

Speaker: Yes.

Audience Member: This data that was analyzed against actual rainfall, is it mostly from the 20th century? From 1901 to 2002?

Speaker: Yes.

Audience Member: In the later part of the 20th century, the variations are more pronounced because of climate change, so this correlation might not be very clear. Have you done any kind of statistical modeling with the *Kṛṣiparāśara* model? Is there any similarity between the *Parāśara Tantra* and what the *Kṛṣiparāśara* says about rainfall prediction?

Speaker: The *Kṛṣiparāśara* uses a different kind of statistical modeling... I haven't done that specifically. But yes, the core model is correlated with the modern data.

Audience Member: So, if you get rainfall in all the *nakṣatras*, what exactly is a "male" *nakṣatra*?

Speaker: That is why I mentioned earlier that those specific categorizations belong to that last part—the metaphors and portents.

Lecture by Prof. R. N. Iyengar (12)

Astronomical Significance of the Navagraha and Vedic Cosmology

Yesterday also I showed this. And this has been commented by Utpala because the first shloka is from *Bṛhat Saṃhitā* and that is where *Bṛhat Saṃhitā*, Varāhamihira says: *Parāśara-tantre nakṣatraiḥ kīrtitā gatayaḥ*. So *Parāśara-tantra* was a well-known book in those periods, in the 5th century CE. Only now have we reconstructed; that's all. Like this *Ghatasaṅkalana* was also a reconstruction, what I showed. When I saw this *Ghatasaṅkalana* and all of that is reconstructed, I thought I can also reconstruct *Parāśara Hora*, even though the word *Parāśara-tantra* is used in *Bṛhat Saṃhitā*. So I will take the same title because it is established by Varāhamihira himself that there was a text of that kind. So that is how we reconstruct. That was the inspiration for me to do this work.

Observational Cycles of Shukra (Venus) and Budha (Mercury)

Oh, something you can't read, but something else you are able to read. What it means is the following: the five positions are given in the *Parāśara-tantra* book, it's there you can read it very easily. What it says is—the English I have put up—when the Shukra, you know, in the East you can see, keeps on rising, rising each day, goes to a higher height, then goes to the maximum elongation as it is called, then keeps on going down each day. You can see only before sunrise, not after sunrise. Then comes down and sets, vanishes somewhere in the East. If you see only the East, only I am talking about, nothing else.

Now once it sets, it remains set for some number of days. And that number of days was known. He says: "Venus, having set in the East along the five paths, becomes visible after 55, 65, 70, 81, or 90 days respectively." Where does it rise? In the West. So for so many days, you can't see. That doesn't mean suddenly it comes after 65 or whatever, please see that. Once it happens, it goes down, you wait, after some days it comes in the West. West also it moves for about three months it will be there, and sets. And it rises in the East after 6, 8, 12, 15, and 24 days. This is all observation material. Why they have given it so carefully?

If it sets in one nakshatra, it will not rise in the same nakshatra. It will rise in some other nakshatra. Or in other words, yesterday Hariharan was mentioning about the Venus signature for rainfall in the *Varsha Ritu*. It is seen in the East, then it's good rainfall, is what you are telling. Because it is absent in the East for so many days. But when it's seen in the East, it's not exactly in the same place. Like Sun moves, rise keeps on changing; Shukra also moves on changing when it rises. But it rises in five fixed places. For Sun, you have 366 days, or 183 days this way, 183 days this way, because we are so closely connected, we don't think of this at all.

The Pañcakoṇa (Pentagon) Geometry

But for Shukra, there are five specific places. And those five points in the nakshatras, if you plot, you get that *Pañcakoṇa*, you get a pentagon. That is why this five is important. Why that pentagon is important? The mantra which I think Shreedhar... has he come back? Oh, he's there,

he's there, he's there. You were talking yesterday about *adhidēvatā*, *pratyadhidēvatā*, that's what I'm covering because you raised that question.

The Shukra, *Yaḥ śukra ityata anyē tējayanta anyē viśvarūpē ahanī dyaurivāsi*, is the Rigveda mantra, which is used today in the Navagraha poojas in the South—at least in the South, there can be slight difference in the North. And *Indrāṇyai*, first is Indrāṇī who comes. *Adhidēvatā*, *pratyadhidēvatā*. *Indrāṇīmāsu nāriṣu subhagā* etc., it is again 10.86 Rigveda. Then *Indrāya*, because Indra is the *pratyadhidēvatā*. *Indraṃ vō viśvatasparī havāmahē janēbhyaḥ asmākamastu kēvalaḥ*, again Rigveda. These are the mantras.

And how do you do the *āvāhana*? *Bhagavantaṃ śukraṃ prāṅmukhaṃ sūryagrahasya pūrvadigbhāgē pañcakōṇākāra maṇḍalē*. Where is that *pañcakōṇākāra maṇḍala*? That is what I showed you in the previous graph. He is always in this *pañcakōṇākāra maṇḍala*, astronomical, observational, *Parāśara-tantra* related, known for already some 3,000–4,000 years. And today this tradition remains. Some people know this, some people don't know this. And again these are all going to be going round Meru and coming. The whole mantra is very long. If the Vedic way it is done, it is all available in the *Āśvalāyana Sūtra Pariśiṣṭa*; that would be the Vedic way of doing the Navagraha pooja and the Navagraha homa. Āgamika and Paurāṇika will all be different, and *laukika* will all be different. What you do in the temple going and doing, it is a *laukika* kind of Navagraha pooja—nothing lower, don't think like that, it's the emotions which are important—but this is more accurate astronomically and celestially, with what they observed. Otherwise, they would not have got the *Pañcakoṇa*.

Geometry of Other Grahas

Now somebody asked me: "Sir, what about Budha?" Budha also we know is an inner planet. It is quite well-known now that there are some kind of cycles, there is a symmetry, what you may say. There's a five-pointed symmetry for Shukra. So whatever you take with Venus, there is a five-pointed symmetry. You understand this symmetry, it is always going to be 5, 5, 5. Even in the West, the rising, you mark the points, it's always five. You take only the setting, it is also five. *Pāṅktō yajñaḥ*.

This is actually why Indra came up, you can now relate: Indra is *kāla-abhimāni*, Shukra is also *kāla-abhimāni*. And Shukra is the person who manages this time pretty well. And Shukra is also called *tiryak-gati* like Surya in the lexicons and other places it is given. Now I will not go into all those details, but for Budha what is seen? If I take the eastern visibility of Budha—this is plotted actually by Sundar, I think Sundar hasn't yet come—in the various nakshatras for a particular period, about five years or so, you get this kind of figure. It is not the *Pañcakōṇākāra*, but you get this which is like a *Cāpa*, actually a bow.

And it is in the *Cāpākāra* is mentioned in one of the things also, the mandala for Budha is *Cāpākāra*. The others we will not worry, I'll have to quickly complete this talk. Okay, so this is the *Āśvalāyana Pariśiṣṭa* I'm showing where all the details are given. For each and every one of the grahas, how it should be, *āvāhana* has to be done, what is the *pīṭha*, what color has to be

used: *tāmra* (copper) for Mars, and *rajata* (silver) for Shukra. And what kind of *puṣpa* (flower) should be used, what kind of *tila* (sesame) or the rice should be used, all that is available from the original Vedic practice itself.

Critique of Modern Navagraha Yantras

Now this is the available which you can order on Amazon online or whatever you know—the Navagraha Yantra which is sold. Extremely unhappy with that, because you can see Shukra they are showing as a hexagon. Can you see that?

Now Sun has to be circle, that is okay, even in the text it is going to be like that. The Moon also would be a circle, and for Mars it is generally a triangle, *Trikōṇākāra*. So that *Trikōṇākāra* is there, here the *Trikōṇākāra maṇḍala*. Then for Rahu, it is generally *Śūrpākāra*. Because Rahu's shadow, if you remember or move, recently you had the lunar eclipse, sometimes it will be part, sometimes it will be full. So when it is partial, the shadow will be only like *śūrpa*—will be, you know, in *winnow*, *mora* in Kannada it is called, I don't know in Hindi what it is called—it's a winnowing, you know, you take rice and wheat and other to do like this so that the dust and other things go out, that is a *śūrpa*. So Rahu is like that. And Ketu is *Dhvaja*, generally it is shown as a *Dhvajākāra*. *Dhvaja* is a flag. Yeah, comets, they look like flags or they are like the flags of some God or something like that, that is the thing.

It is to the *pūrvadigbhāga* (eastern part) of Sun, but here it is taken as a hexagon. I have seen in some of the other paintings, and there is so much of art with Navagraha, you know: Navagraha rangoli, Navagraha painting, Navagraha images, hundreds and thousands are available. In one way it is very good, but you know this is forgotten. And then for Budha, they show a *Bāṇākāra* (arrow-shape), not a *Cāpākāra* but a *Bāṇākāra*. Whatever may be the reason, *cāpa* and *bāṇa*, they are after all, *bāṇa* is the arrow, *cāpa* is the bow, whereas for Budha it was originally *cāpa*. Though it has got interchanged perhaps, it doesn't matter. This is the nine today in use, right?

Comparative Study and Cometary Observations

And hence my suggestion that when we study this, it is better to have some comparison with the religious things also, at least have in mind. At least we can tell people how it was and all that. And Ketu was not at all the descending node. And Ketu is not kept opposite Rahu. That tradition is followed. Ketu and Rahu, they are in two other corners, they are not kept one opposite the other at all. Whereas Shukra and Budha are kept near and to the east of Sun. Of course, it's a small place, you can't capture all of them, but this is the situation.

Now there are also birth of the planets, *srṣṭi* is one thing, but in the Puranas there is what is called *Grahotpatti*. And in the *Grahotpatti*, which nakshatra which graha was born is said: *Vivasvān ditya putraḥ sūryō vai cākṣuṣē'ntarē*. In the Chakshusha Manvantara, *Viśākhāsu samutpannaḥ grahāṇām prathamō grahaḥ*. All the Puranas give this. I've taken it from *Vāyu*, others also give the same. *Sōmaḥ śītaraśmiḥ samutpannaḥ kṛttikāsu niśākaraḥ*. This may be the equinoctial full moon case which we analyzed, possibly, because these are the equinoctial points, Krittika and the Vishakha. So all this, as the Puranas timing matches with the Magadhi

period—which I have already demonstrated two days back, Krittika 1/4th and Vishakha 3/4th and all that—all of this might have originated during that, which is missing from *Mahā-saṃhitā* and other texts because there is no *Grahotpatti* given in *Mahā-saṃhitā*. But nakshatras are there, graha dimensions are there, *graha-rashmis* are there. So it is quite possible this also contains information about the inner planets you see. And these may be a kind of perihelion positions or perihelion and aphelion positions or where they were looking very small or very big, some observational thing may be.

But you know the order is this, then comes *Ṣōḍaśārciḥ* that is Shukraḥ, grahaḥ *Aṅgirasaḥ putraḥ dvādaśārciḥ*. It's the same thing in *Mahā-saṃhitā* also, *dvādaśārciḥ*. Then *Lōhitāṅgaḥ prājāpatisukha grahaḥ*... he sometimes they give the *rashmi* sometimes they don't give, that doesn't matter. *Saptārciḥ sauraḥ*, Saura has seven rays, same thing there also. *Tārāgrahāścaiva bauddhavya bhārgavādayaḥ* blah blah all of that. Now sometimes these are broken, sometimes given in full. This we have not investigated, somebody here may take it up and analyze it further.

Epics and the Eclipse of Astronomical Understanding

Why I had to say this? Once again we come to a little bit of *Mahābhārata* before I close, that is again the Puranas in some sense. Rahu and Ketu, they cause an awful lot of problems. Now people do Navagraha homa, Navagraha pooja, and they do a kind of *vrata* and all of that, with some kind of feeling that they are having. And they think always Rahu and Ketu are opposite, because many people would keep their horoscopes there, you know, for the Navagraha. Because somebody would have told them "In your *jātaka*, you see Ketu is in the bad place so you have to do something," or "Rahu is in the bad place, you have to do something; do Navagraha pooja, everything will be alright" or whatever. Is the usual case.

But these poor people, they would be thinking Rahu and Ketu are going to be the ones which are causing the eclipses. You can't see Rahu, you can't see Ketu, they are points, imaginary points. Like the equinoctial point, you can't see. But when the graha is there, you know what is that graha. So that position is very important for us to do a *dhyāna* or whatever. So when they have to think of that, you have to do the *dhyāna... dhyāna-shloka* of a particular graha, otherwise I can't. The *rūpa-samriti* is very important. You have to have the same kind of thing. You say *Caturmukham*, and you don't imagine four *mukhas*, or you say *Caturbhujam* but you think of somebody with a *aṣṭabhuja-mūrti* or whatever, it won't lead to the right concentration. Simple as that. I'm not going into the Vedantic technicalities, but normal human beings I'm telling.

Now you see the *Mahābhārata*, Rahu, Ketu, so many things come up. We will not go into detail. There is in the *Bhīṣma Parva*, I'm giving here is the Gorakhpur edition with the translation and also the text—actually, it's the text of Neelakantha's commentary on that. And I don't think you'll be able to read: *Rāhu-Kētū sadā samasaptakau adya ēkarāśigatāviti bhāvaḥ* he says. So the details you have to read, I have also published of this. *Dhūmakētuḥ* with the Pushya star it has mentioned, *Dhūmakēturmahāghōrā puṣyamākramya tiṣṭhati* or something like that. It also refers to *Śvētō grahaḥ citramākramya tiṣṭhati* is also there. So Neelakantha

(17th century) says Rahu and Ketu were together in the same side during the war. Because Chitra and Pushya, they come together, so so he's telling that it is in the same rashi. How is that possible? And he also says *sadā samasaptakau*, normally they are opposite each other but today they are together. That means the ecliptic had broken, or the nodes were broken, Moon should have hit Earth; that was the only way it could have been. That has not happened.

And this interpretation is simply wrong, because he took Ketu to be 180 degrees away from Rahu. That is a degeneration of Siddhantic astronomy combined with the older horoscopic Hora, part of which came from outside. Because in the Islamic astronomy, concepts of these kind are there, that it is the same *sarpa* (snake) or the Rahu goes and its tail is also there. That is an astronomical concept of the two nodes. We will not go into those details. But here you can see, this leads to some kind of problematic issues. I don't know how many agree with me or not, but he has... this has been translated—Neelakantha's commentary in English translation of *Mahābhārata* is available, Kishari Mohan Ganguli and after that reprinted also. Ganguli says he follows only Neelakantha. All astronomical things are put as astrological things. Each and every one of them are interpreted as astrological.

Natural Disasters and the Sarasvati River

So how can you argue on such a text? Now people want to know the date of *Mahābhārata* based on astronomical things. The complexity or the controversy is going to be this: which you take, which you omit, how do you interpret. There are 100 interpretations for the same shloka. So you have to be cautious of these things. Now there are quite a few... no no, let me complete, we'll talk. This comet imagery, there is a kind of connection with the country actually, not just the celestial thing. Because it has caused disasters also. See *Brahmadaṇḍa viniṣpiṣṭāḥ samīpē lavaṇāmbasā*. Who? The Vrishnis. *Yatra tē puruṣavyāghrāḥ śastrasparśasahā yudhi*. It is in the *Ādi Parva* but it indicates the Yadavi-kalaha which was happened. It was a *Brahmadaṇḍa viniṣpiṣṭāḥ*. This comes in the *Mausala Parva* and it is as *Mausala Parva* is explained as a *musala*, which you remember the story—Vishvamitra giving a *shāpa* (curse) to Samba because he wants to tease Vishvamitra: "When am I going to deliver my baby?" That's what he asked. Vishvamitra knows, he says: "With the same *musala* you are going to die hit and die." This is the story which comes there.

And *Parāśara-tantra*, *Vṛddha-Garga*, *Bṛhat Saṃhitā*, all of them say *Brahmadaṇḍa* was a comet. Now in interpretation, you'll say *Brahmadaṇḍa* is some creator's, you know, *shāpa* or something of that kind. Or in the *jātaka* something is said, they'll say that. And in the *Uttathya Upākhyāna* in the *Anuśāsana Parva*, the comets something coming and and falling and Sarasvati river shifting to the West is also mentioned. That is *Darśayiṣyastalaṃ baddhrē ṣaṭsahasra śatahradami*, that created 60,000 openings. *Tatastiraṇaṃ jātaṃ samudraścāpasarpitaḥ*, became *iraṇa* (arid) and Samudra went back. Comes again in the *Skanda Purāṇa*, and it was dry, there was no *Sāgara* for about 1,000 years he says. Then later on it came—1,000 may be 100, I don't know. Well you can read for yourself, I'm not going into the details.

Iraṇa is Rann of Kutch. And you go to Rann of Kutch, you even today you can see large number of openings. Whether they are all openings due to this I don't know, it may be geological also. But the story of people going into Patala and the *Kathāsaritsāgara* and so many places they all originated out of this. And it continues: the birth of Kartikeya yesterday was mentioned, is again connected the whole thing from *Mahābhārata*. And for six days how it increased, how it broke down, and how it came down, all that is given there. And connected starting with an *Amāvāsyā* and then coming in the *Śukla-ṣaṣṭhī*. It is in the *Śukla-ṣaṣṭhī* only the Subbaraya Shashti and those things are observed even today, you know. And that Subbaraya Shashti or Subrahmanya Shashti is connected with this. Subrahmanya is same as Kartikeya and his Mahasena. Here it is there, it gives somewhere Mahasena.

Impact Material and Emigration

And this comet imagery is in several places. I am stressing this because Parāśara and Vṛddha-Garga discusses comets. *Mahā-saṃhitā* says there were 101 comets. At least a few comets should have been known to people, you know. *Mahābhārata* knows at least some 5–6 comet imageries, comet happenings, that they had seen. You take only the planets as realistic because you want to fight about the *Mahābhārata* date, don't take comets as important. And the *Śānti Parva* also comes, this is about the famine. Why all this happened? Because the comets or some parts of it fell down, and the *Sāgara* went back, and Sarasvati got went to the West and dried up, and all the people who were in the Sarasvati tira, all the Saptarishis who were in the Sarasvati tira, they got distributed, they went out of that place. So it is actually an emigration from the Brahmavarta region to the other regions. People might have been living even previously, but you can't put a date specifically on these things from the text. But it is remembered. Because the people who faced the disaster, they can't say anything, they are all gone. Only the new, their progeny can have the legend and they can relate the stories through poems and writings, you know, the folklores.

So that is how these have developed. And it discusses the famine so clearly: *ucchinnakṛṣigōrakṣanivṛttavipaṇāpaṇā*. There cannot be in any language a description of a famine so serious as this, but so sharp, crisp. Because each word you can write one page. *Ucchinnakṛṣigōrakṣanivṛttavipaṇāpaṇā*. So all the *kṛṣi* (agriculture) and all veterinary things they have gone, *nivṛttavipaṇāpaṇā* trade, buying and selling of commerce. *Nivṛttayūpa*, *yūpas* were gone, that is for the yajnas, *sambhāras*, they were all gone. *Vipranaṣṭamahōtsava*, all the *mahōtsavas* what people were celebrating, that was all gone. Then what happened? *Asthisañcaya saṅkīrṇā*.

It is the COVID which you would have seen in the TVs, how the in the TV you know the crematory mediums and they were all shown. Not only in India, in the other countries how it was happening. *Asthisañcaya saṅkīrṇā*, simple Sanskrit. *Mahābhūtaravākulā*, people crying. *Śūnyabhūyiṣṭhanagarā*, everything was nagaras were all empty. *Dagdhagrāmani-majanā*, all *grāmani-majanās* they were burnt. This goes like this, I will not go further.

And even further he says: *adyāpi itihāsaṃ prāhuḥ*, even now they say this as a historical issue in the *Mahābhārata* time they are telling. *Viśvāmitrasya saṃvādaṃ caṇḍālasya ca pakkaṇē,*

itihāsaṃ purātanam atrāpyudāhṛtam. That is what in the *Śānti Parva*, Bhishma is supposed to be telling to Yudhishthira. Both Bhishma's death to any era I don't care, should be some 1,000–1,200 years before. So during the Vedic period, the transition when the Sarasvati river dried up, there were major problems.

Conclusion: The Sarasvati's Path

Okay, this is I think my last one. Even otherwise I will stop here. This is the Sarasvati region. The Sarasvatas are supposed to have emigrated out of this after when the Sarasvati river dried up. Because not over one year or two years, must have happened over several generations, you know. And some could have gone in the other direction. So now don't worry about AIT (Aryan Invasion Theory) and OIT (Out of India Theory), and Shrautha Sutras some other they say the Amavasus and the Druhyus went to the Northwest. Quite possible and others went in the other direction. That doesn't mean there were no people in South and Ganga... don't think like that. But when the this happened, it there was some *anayas* as they call it, there was a population movement would have happened, large scale population movement. This even now happens. The Chamoli earthquake happened in the Himalayas, at least about 5,000 people emigrated to the plains. And invariably this kind of things happen. The Gujarat earthquake happened in Bhuj region, many of the families emigrated out to other cities because they have to look for livelihood, you know. So they have to search for that for them and for their family. This is a common thing all over the world, let us not be very worried about that.

But this Sarasvati Sindhu system, what it says is: this Yamuna which is like this, it was flowing in this direction but it bent and went away because of some geological formation. Yesterday I was telling about Indra hitting the Arbudha... okay this is my last one, so I will stop here. Indra hitting the Arbudha and Arbudha going down, so that river had to cut back. All this is very poetically described in the *Skanda Purāṇa*.

And there is one shloka which I like it very much: there is a called a place called Prācī Sarasvati. Today it is called Pehowa or something like that. Now we are talking after about 4,000 years or whatever because Sarasvati was supposed to have dried up around 2000 BCE, or maybe 100 plus or minus 100 years. What *Skanda Purāṇa* says would have remembrance of that for some 3,000–4,000 years and writing it. Says there is one place where Sarasvati turned East; that is the Prācī Sarasvati. Flowing West, there is one place even today it turns like this in the opposite direction and then bends and goes forever like that. When she turned like this, she cries, Sarasvati cries looking at Ganga. Because she says we were flowing together previously, now I have become alone, I have become a *ēkākī*. So turning to the East and she cries, then after some time she turns West and goes back, goes into the *Araṇyā-varta* that is into the sea. Now you see, is it geological, geographical, or is it poetical, or is it imaginary, or is it religious? Because Pehowa even today it is a very important place for doing *shrāddhas* and other things.

There is a Kartikeya temple also there. And Kartikeya is same as this Mahasena, same as the *Mahābhārata*, that same Shanmukha or Muruga. And it's not that Shanmukha Muruga is only South India, no. North Indians also worship, maybe the tradition might have changed, or in

some other manner it may be doing. And he's actually a Vedic God, from the Rigveda period. As a form of Agni. I think that is sufficient. I think the coffee is ready, can break.

Q&A Excerpt

Participant: Yes, sir. Pehowa?

Prof. R. N. Iyengar: Pehowa. What do you want?

Participant: So the name of the place you said...

Prof. R. N. Iyengar: P-E-H-O-W-A. That was originally called Pṛthūdaka. You can do Google search.

Participant: Originally called...

Prof. R. N. Iyengar: Pṛthūdaka. In fact, there is a commentary on... what is that text? *Brāhmasphuṭasiddhānta* by Pṛthūdaka Swāmi, and he was living in that in the Pehowa, the Prācī Sarasvati.

Participant: In *Mahābhārata*, there is one point: before the war... Krishna does *tarpaṇa* and he brings the Sun and Moon together and he changes... brings an *Amāvāsyā* to happen...

Prof. R. N. Iyengar: I have not come across this. But... because there is law... awful lot of, you know, the interpolations is one thing, concept of *tarpaṇa*. Now Dharmashastras but even particularly *Mahābhārata* says: when a comet is seen, a *tarpaṇa* should be there. How many people do now? It is not even mentioned, they just don't know. But if you see in Paurāṇika Dharmashastra, it puts in a footnote. Yes, some of the Dharmasutras say that when a comet is visible, *tarpaṇa* should be done. But in the *Mahābhārata*, they would they would do it. And *ahi* is there. See the reason is I think the whole thing is astronomical, particularly about comets. Do forget about eclipse, forget about your nakshatras and planets. First study the comets. Comets were the most important thing, omen indicators, in the *Mahābhārata*. At least in the text I'm telling. Now a days I don't know. There are some 10 to 15 places these comets are mentioned. First we have to sort them out. Then we can go to the other.